AD-A041 180 WYLE LABS HUNTSVILLE ALA F/G 13/12
SELECTION AND EVALUATION OF PLEASURE BOAT CAPACITY PLATE DESIGN--ETC(U)
NOV 76 E SAGER, M PFAUTH, G LANCASTER, T DOLL DOT-CG-40672-A
UNCLASSIFIED MSR-76-50 USCG-D-18-77 NL

1 OF 2
AD
A041180

Report No. CG - D - 18 - 77

13

SELECTION AND EVALUATION OF PLEASURE BOAT CAPACITY PLATE DESIGNS

Wyle Laboratories
7800 Governors Drive, West
Huntsville, AL 35807

NOVEMBER 1976

FINAL REPORT

Prepared for

U. S. DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD
Office of Research and Development
Washington, D.C. 20590

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
CG-D-18-77		

4. Title and Subtitle	5. Report Date
SELECTION AND EVALUATION OF PLEASURE BOAT CAPACITY PLATE DESIGNS	November 1976
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
E. Sager, M. Pfauth, G. Lancaster, T. Doll	MSR-76-50
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Wyle Laboratories P. O. Box 1008 Huntsville, Alabama 35807	11. Contract or Grant No. DOT-CG-40672-A, T.O. 16
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address Department of Transportation United States Coast Guard Office of Research and Development Washington, D. C. 20590	Final Report May 1976 - November 1976
	14. Sponsoring Agency Code USCG (G-DSA)

15. Supplementary Notes

U.S. COAST GUARD PROJECT OFFICER: Mr. Paul McMahan, G-DSA-2

16. Abstract

Four studies were undertaken to deal with several aspects of the boat capacity labeling question. The first study determined boaters' awareness of capacity information on their own boats. It was recommended that designs used for present capacity plate labels be revised. The second study explored boaters' reactions to nine capacity plate designs on dimensions of attractiveness, simplicity, authenticity, and general preferability. In the third study, selected designs were tested for comprehension using tachistoscopic displays and a "match to sample" procedure. The results indicated further testing of one design, modifications for another design, and the discarding of a pictorialized design. The fourth study was an evaluation of the effectiveness of designs in an actual boat rental situation. The results indicated that two types of designs were most likely to communicate the capacity information. The characteristics of these two designs were recommended as guidelines for the deveiopment of production capacity plate labels.

17. Key Words	18. Distribution Statement
Label Effectiveness, Capacity Plates, Boat Capacity	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	108	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly).

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

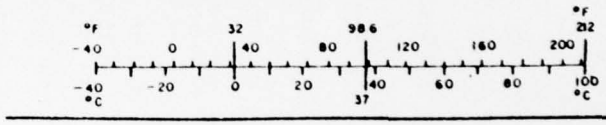
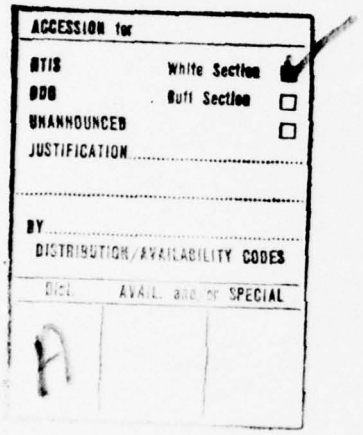
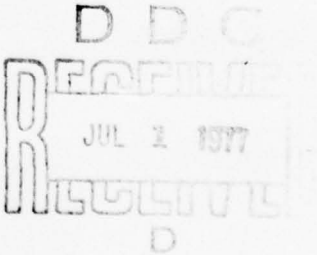


TABLE OF CONTENTS

TABLE OF CONTENTS, CONTINUED

TABLE OF CONTENTS, CONCLUDED





SELECTION AND EVALUATION OF PLEASURE BOAT CAPACITY PLATE DESIGNS

1.0 SUMMARY

1.1 Boaters' Awareness of Their Boat's Capacity Limits -- Study 1

Four studies were undertaken to deal with several aspects of the boat capacity labeling question. The first study was conducted to determine the current level of knowledge on the part of boat operators with respect to the safety-related characteristics of their boat (capacity limits of the boat). Wyle researchers interviewed 200 boat owners by telephone and 157 boat owners at launch ramps located at five sites across the country. The results indicated that only a small portion of boaters accurately estimated their boat's weight capacity. However, most boaters surveyed knew where the capacity plate was located. It was recommended that the presentation of information on capacity plate labels be evaluated in subsequent research.

1.2 Selection and Evaluation of New Capacity Plate Designs -- Study 2

The purpose of the second study was to explore boaters' reactions to nine capacity plate designs. Evaluation of the designs was based upon boaters' ratings of attractiveness, simplicity, and perceived authenticity, and a forced choice for general preferability. The results suggested further evaluation of relative effectiveness for three basic designs.

1.3 Selection and Evaluation of New Capacity Plate Designs -- Study 3

The purpose of the third study was to determine boaters' comprehension of capacity information presented in the three basic capacity plate designs: 1) pictorialization or no pictorialization as an adjunct to the capacity recommendations, 2) emphasis of capacity recommendations using a design that combined all recommendations in one enclosure or separate enclosures for each recommendation (multiple enclosures), and 3) variation of the order of information (verbal information first and numerical data next and vice versa, e.g., "Weight 937 lbs" vs "937 lbs Weight"). In addition, the Boating Industry Association (BIA) capacity plate now in use was evaluated for comprehension effectiveness.

The capacity plate designs were prepared on 35 mm slides and presented tachistoscopically to two experimental groups of boaters (eleven persons each). Each group received one alternative form of the design. The task was to view the momentary displays and to identify capacity information that was identical to information given at the start of the series. It was assumed that comprehension of the information (or a basic level of understanding) was necessary to enable the boaters to distinguish between identical and non-identical information. The outcome indicated that pictorialization did not necessarily facilitate comprehension of the capacity information, and that the numberical/verbal order produced better comprehension of the capacity information. The use of multiple enclosures was inconclusive and further evaluation was warranted in the next study. All new capacity plate designs produced better comprehension than the BIA design.

1.4 Evaluation of New Capacity Plate Designs According to Aspects of Safety-Related Behavior -- Study 4

The purpose of the fourth study was to evaluate the effectiveness of selected capacity plate designs in an actual boating situation. The criteria for the evaluation was boaters noticing, reading, and retaining the capacity information. It was assumed that retaining the information was a consequence of comprehending or understanding the information. The capacity plate designs evaluated for this phase of the project included: 1) multiple or single enclosures (as in the previous study), 2) larger or smaller type face for the numerical data in the capacity recommendations, and 3) including the maximum motor horsepower recommendation inside the main enclosure with other weight capacities, or presenting the horsepower recommendation below the enclosure. The various designs were prepared as actual capacity plates and were mounted on a fleet of rental fishing boats. The boats were rented to fishermen in the normal manner at a fishing camp. When each boat was returned, the operator of the boat was interviewed by a Wyle researcher. The interviews indicated whether the capacity plate in each boat was noticed, when it was noticed, if it was read when noticed, and the boat operators' retention of the capacity information. The results of the study indicated that the single enclosure designs using larger or smaller type face for numerical data were more likely to communicate the capacity information. The characteristics of the designs were recommended as guidelines in the development of production capacity plate labels.

2.0 GENERAL BACKGROUND AND OBJECTIVES OF THE PROJECT

The task of informing recreational boaters about the capabilities and limitations of their boats is receiving considerable interest from the U. S. Coast Guard and the boat manufacturing industry. One method presently used for informing boaters of the capacities of boats is the "capacity plate" fixed to the hull. Installation of this capacity plate is required by the U. S. Coast Guard on all boats up to 20 ft (6.1 m) in length manufactured after November 1, 1972. The limitations to be specified on the capacity plate include: maximum allowable weight for persons, motor, and gear combined; maximum allowable weight for persons only; and maximum allowable motor horsepower (if the boat is outboard motor powered).

Research by the USCG Research and Development Center indicates that 50% of the recreational boating fatalities each year are associated with boat loading types of accidents. Currently the BIA (Boating Industry Association) is considering revision of the capacity plate design now in use. The intent of the revision is to maximize the effectiveness of the required capacity plate in terms of informing boaters of the recommendations, and in terms of achieving compliance with the recommendations. In short, the revised capacity plate design should inform boaters of the capacities of the boats in a meaningful way.

This project was authorized for the study of three aspects of the boat capacity labeling problem. The objectives for the study correspond to the divisions of Subtasks I, II, and III and are as follow:

1. To determine the current level of knowledge on the part of the boat operators/owners with respect to the capacity limits of their boats.
2. To evaluate the potential of new capacity plate designs to attract the boaters' attention, and to communicate the capacity information.
3. To determine if new capacity plate designs lead to safer behavior on the part of boaters. In effect, the second and third objectives translate as the evaluation of the capacity plate designs for the likelihood that each design will be noticed, read, and the information comprehended.

2.1 Organization of Studies and Subtasks for Implementing Objectives

The project was carried out in four separate studies within the three Subtasks. Study 1 dealt with the first objective, and was conducted by Wyle researchers G. Lancaster and T. Doll. This study constituted Subtask I. Studies 2 and 3 dealt with the second objective. Implementation of the second objective involved the selection of design alternatives according to their attention effects relevant to communication of information (Study 2), and selection of design alternatives according to the relative ease of comprehension of the capacity information (Study 3). Studies 2 and 3 were conducted within Subtask II. Study 4 dealt with the third objective, and coincided with Subtask III. The intent of Study 4 was to make a final selection of effective designs based upon attention and communication attributes (noticing, reading, and comprehension). Subtasks II and III were conducted by Wyle researchers M. Pfauth and E. Sager.

3.0 SUBTASK I -- BOATERS' AWARENESS OF SAFETY-RELATED CHARACTERISTICS

3.1 Introduction

Recent research (Reference 1) by the U. S. Coast Guard Research and Development Center indicates that 50% of the boating fatalities each year may involve loading-related accidents. They used the following definition in constituting a "loading-related accident":

> Accidents which are related to a recreational boat's stability, freeboard, capacity, and 'motions' characteristics. 'Motions' is defined as a boat's performance while drifting, proceeding on a straight course at moderate speed, slow speed maneuvering or undergoing changes in throttle (on/off plane) or direction in such a manner as to cause suspicion of the boat's ability to react properly to the imposed maneuver.

The general population of boats includes millions which have capacity plates and millions which do not. It is not possible to evaluate the safety benefit derived from capacity plates through an analysis of present accident data. The nature of the data available from Boating Accident Reports prohibits this analysis.

The U. S. Coast Guard has adopted several programs to educate and inform boaters about safe boating practices. One means of informing the boater is to label his boat or boating equipment. How can the effectiveness of such labels be evaluated? Capacity plates exist on a large sub-population of boats, and they have been the subject of previous studies (Reference 2).

The objective of this report is to determine the current level of knowledge on the part of boat operators with respect to the safety-related characteristics of their boats. The safety characteristic under study for this report is capacity limits of boats.

3.2 Method and Results

Information was obtained from two sources: (a) telephone interviews and (b) on-site interviews at launch ramps around the country.

As part of Subtask I of the previous Safe Loading Research (Reference 3), Wyle conducted telephone interviews with 200 owners of small boats. Several questions were asked regarding the owner's awareness of the existence and content of the capacity plate on his boat. Of these 200 telephone interviews, 110 contained information which was used to contact the various manufacturers of the boats to determine the actual capacity (i.e., the information contained on the capacity plate) of the boats. Only these 110 cases are used in the present study.

The on-site interviews were conducted at the following locations:

- Guntersville Lake, Guntersville, Alabama
- Cape May, New Jersey
- Point Judith, Rhode Island
- Lake St. Claire, Detroit, Michigan
- Port Aransas, Texas.

The boaters at these various launch ramp sites were asked questions pertaining to their boat's capacity limits. In all, 157 boat operators were interviewed at launch ramps. The interviewer looked at the capacity plate, if the boat had one, and wrote down the actual capacity limit given on the plate.

Several questions were asked about the boat operator:

- his or her experience in hours of boat operating time, and
- whether the operator had taken a boating safety course.

The interviewer also recorded whether the operator was an adult or teenager. Similar questions were asked on the telephone interviews.

Table 1 shows the compilation of the operator data for both telephone and on-site interviews.

Four people did not respond to the question about their operating experience and nine people did not respond to the question about the boating safety course.

TABLE 1. CHARACTERISTICS OF BOAT OPERATORS -- TELEPHONE AND ON-SITE DATA COMBINED

	Frequency	Percent
Operator's Experience		
Under 20 hours	13	4.94
20 to 100 hours	35	13.31
101 to 500 hours	77	29.28
501 hours or over	138	52.47
TOTAL	263	100.00
Operator's Age		
Adult	258	96.63
Teenager	9	3.37
TOTAL	267	100.00
Boating Safety Course		
Yes	79	30.62
No	179	69.38
TOTAL	258	100.00

Of the 267 people interviewed by telephone and on-site, only four interviews were not completed (N = 263). Table 2 shows a breakdown of the boats according to whether or not the boat had a capacity plate.

TABLE 2. CAPACITY PLATE INFORMATION -- TELEPHONE AND ON-SITE DATA COMBINED

Boats:	Frequency	Percent
With Plates	200	76.05
Without Plates	57	21.67
With Illegible Plates*	6	2.28
TOTALS	263	100.00

* These plates were not used in the data analysis.

In both telephone and on-site interviews, operators were asked three types of capacity information for their boats:

- the persons capacity as shown on the capacity plate,
- the maximum capacity (includes persons, motor, and gear), and
- the maximum horsepower as shown on the capacity plate.

The difference between the operators' estimates and the actual capacity stated on the label (or obtained from the manufacturer) was then computed. Figures 1, 2, and 3 show these differences for maximum capacity, maximum persons capacity, and maximum horsepower. As can be seen from these graphs, only about 37% of the operators are accurate to within fifty pounds of the maximum capacity and only about 47% of the operators are accurate to within fifty pounds of the maximum persons capacity. Only about 76% of the operators could estimate their boat's maximum horsepower with an error of less than five horsepower.

To determine the accuracy of the operators' estimates of their boat's capacity limits, confidence intervals were calculated. These data are shown in Tables 3, 4, and 5. For example, the 90% confidence interval for the percentage of the

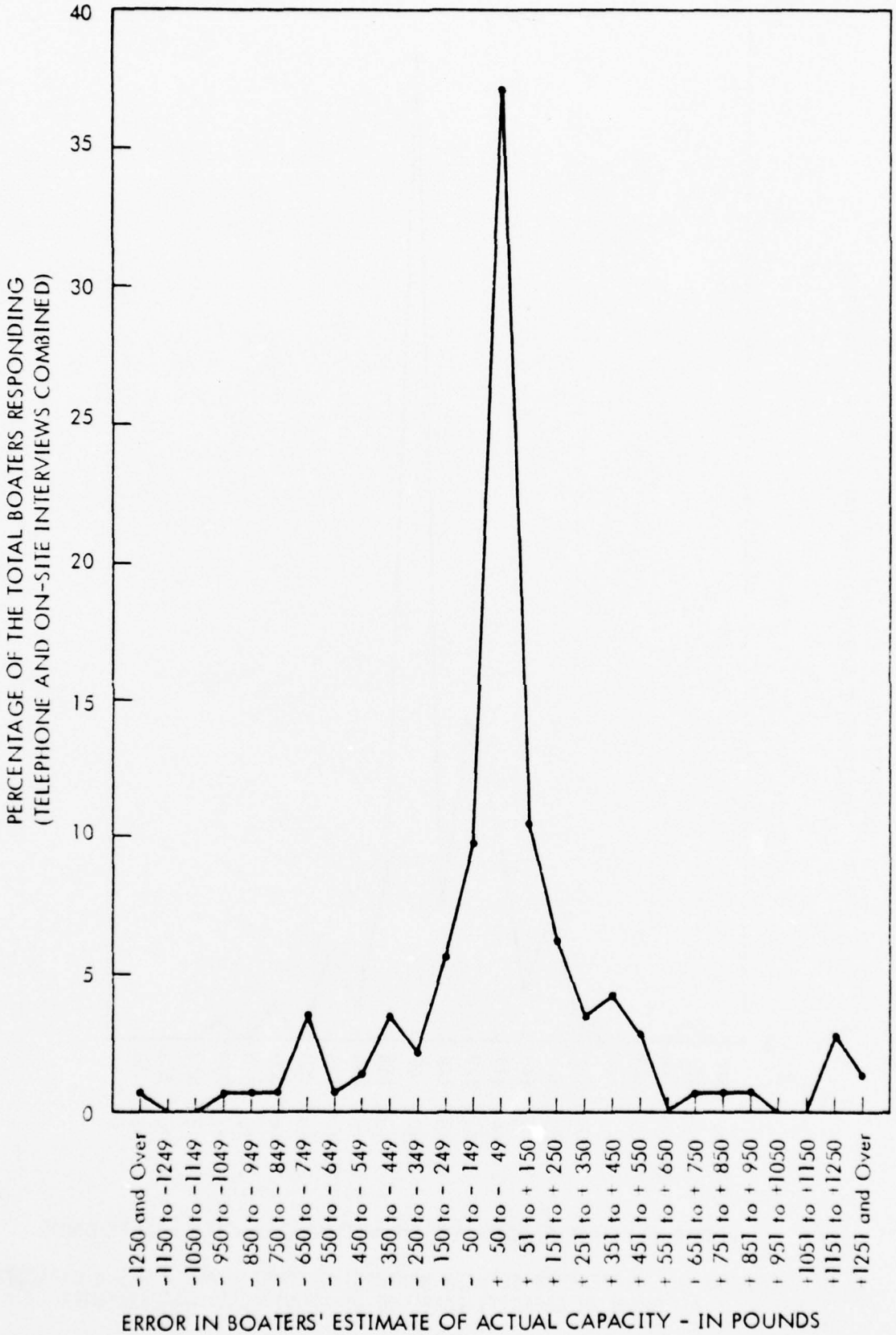


FIGURE 1. DIFFERENCE BETWEEN BOATERS' ESTIMATES AND MAXIMUM WEIGHT CAPACITIES AS SHOWN ON CAPACITY LABELS OR AS PROVIDED BY MANUFACTURERS

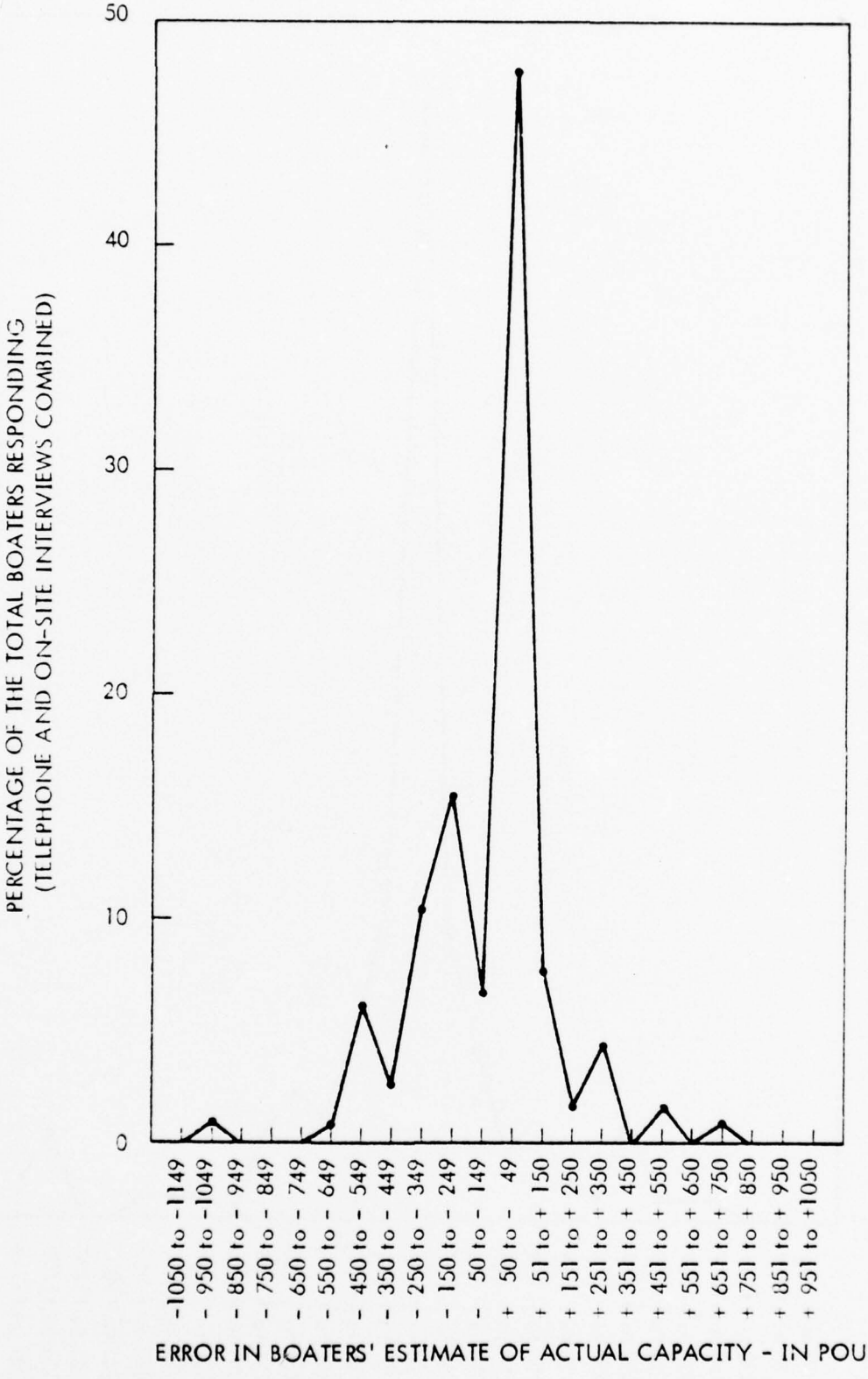


FIGURE 2. DIFFERENCE BETWEEN BOATERS' ESTIMATES AND PERSONS CAPACITY AS SHOWN ON CAPACITY LABEL OR AS PROVIDED BY MANUFACTURER

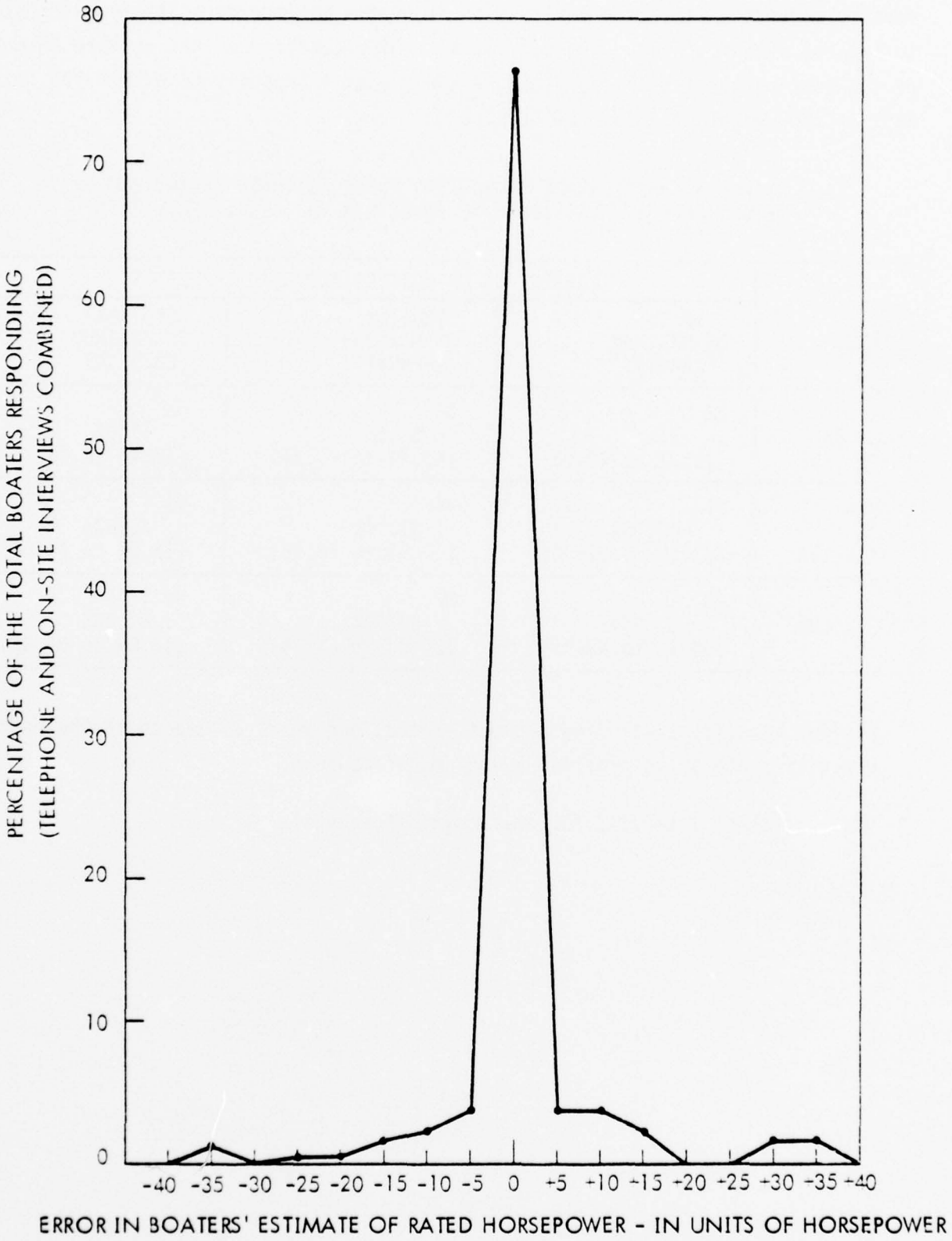


FIGURE 3. DIFFERENCE BETWEEN ESTIMATES AND MAXIMUM HORSEPOWER AS SHOWN ON CAPACITY LABEL OR AS PROVIDED BY MANUFACTURER

boating population that can estimate their boat's maximum capacity to within 150 lb (68 kg) is 50% to 64%. One can say with high confidence that no more than 64% of the boating population can estimate their boat's capacity to within 150 lb (68 kg), or the weight of about one person.

TABLE 3. PERCENTAGE OF BOATERS WHOSE ESTIMATE OF MAXIMUM WEIGHT CAPACITY WAS ACCURATE TO WITHIN THE SPECIFIED LIMITS

SOURCE OF DATA	PERCENTAGE OF BOATERS ACCURATE TO WITHIN:		
	50 lb OF MAXIMUM CAPACITY[a]	150 lbs OF MAXIMUM CAPACITY	250 lbs OF MAXIMUM CAPACITY
TELEPHONE INTERVIEWS	22 31% (21.97 to 40.03)[b]	38 53.5% (43.76 to 63.24)	48 67.6% (58.48 to 76.74)
LAUNCH RAMPS INTERVIEWS	31 43.06% (33.46 to 52.66)	44 61.11% (51.66 to 70.56)	51 70.83% (62.02 to 79.64)
ALL INTERVIEWS	53 37.06% (30.42 to 43.70)	82 57.34% (50.54 to 64.14)	99 69.23% (62.88 to 80.02)

[a] Maximum capacity (including persons, motor, and gear) as stated on the boat's capacity plate or as provided by the manufacturers.

[b] 90% confidence intervals for the above percentages.

TABLE 4. PERCENTAGE OF BOATERS WHOSE ESTIMATE OF PERSONS CAPACITY WAS ACCURATE TO WITHIN THE SPECIFIED LIMITS

SOURCE OF DATA	PERCENTAGE OF BOATERS ACCURATE TO WITHIN:		
	150 lbs OF PERSONS CAPACITY [a]	300 lbs OF PERSONS CAPACITY	450 lbs OF PERSONS CAPACITY
TELEPHONE INTERVIEWS	28 42.42% (32.41 to 52.43) [b]	47 71.21% (62.04 to 80.38)	60 90.91% (85.09 to 96.73)
LAUNCH RAMPS INTERVIEWS	32 65.31% (54.12 to 76.50)	42 85.71% (77.49 to 93.93)	46 93.88% (88.25 to 99.51)
ALL INTERVIEWS	60 52.17% (44.51 to 59.83)	89 77.39% (70.97 to 83.81)	106 92.17% (88.05 to 96.29)

[a] Maximum persons capacity as stated on the boat's capacity plate or as provided by the manufacturer.

[b] 90% confidence intervals for the above percentages.

TABLE 5. PERCENTAGE OF BOATERS WHOSE ESTIMATE OF MAXIMUM HORSEPOWER WAS ACCURATE TO WITHIN THE SPECIFIED LIMITS

SOURCE OF DATA	PERCENTAGE OF BOATERS ACCURATE TO LESS THAN:		
	5 hp	10 hp	15 hp
TELEPHONE INTERVIEWS	75 82.42% (75.86 to 88.98) [a]	80 87.91% (82.29 to 93.53)	83 91.21% (86.33 to 96.09)
LAUNCH RAMPS INTERVIEWS	60 69.76% (61.61 to 77.91)	69 80.23% (73.17 to 87.29)	77 89.53% (84.10 to 94.96)
ALL INTERVIEWS	135 76.27% (71.01 to 81.53)	149 84.18% (79.67 to 88.69)	160 90.40% (86.76 to 94.04)

[a] 90% confidence limit for the above percentage.

TABLE 4. PERCENTAGE OF BOATERS WHOSE ESTIMATE OF PERSONS CAPACITY WAS ACCURATE TO WITHIN THE SPECIFIED LIMITS

SOURCE OF DATA	PERCENTAGE OF BOATERS ACCURATE TO WITHIN:		
	150 lbs OF PERSONS CAPACITY [a]	300 lbs OF PERSONS CAPACITY	450 lbs OF PERSONS CAPACITY
TELEPHONE INTERVIEWS	28 42.42% (32.41 to 52.43) [b]	47 71.21% (62.04 to 80.38)	60 90.91% (85.09 to 96.73)
LAUNCH RAMPS INTERVIEWS	32 65.31% (54.12 to 76.50)	42 85.71% (77.49 to 93.93)	46 93.88% (88.25 to 99.51)
ALL INTERVIEWS	60 52.17% (44.51 to 59.83)	89 77.39% (70.97 to 83.81)	106 92.17% (88.05 to 96.29)

[a] Maximum persons capacity as stated on the boat's capacity plate or as provided by the manufacturer.

[b] 90% confidence intervals for the above percentages.

TABLE 5. PERCENTAGE OF BOATERS WHOSE ESTIMATE OF MAXIMUM HORSEPOWER WAS ACCURATE TO WITHIN THE SPECIFIED LIMITS

SOURCE OF DATA	PERCENTAGE OF BOATERS ACCURATE TO LESS THAN:		
	5 hp	10 hp	15 hp
TELEPHONE INTERVIEWS	75 82.42% (75.86 to 88.98) [a]	80 87.91% (82.29 to 93.53)	83 91.21% (86.33 to 96.09)
LAUNCH RAMPS INTERVIEWS	60 69.76% (61.61 to 77.91)	69 80.23% (73.17 to 87.29)	77 89.53% (84.10 to 94.96)
ALL INTERVIEWS	135 76.27% (71.01 to 81.53)	149 84.18% (79.67 to 88.69)	160 90.40% (86.76 to 94.04)

[a] 90% confidence limit for the above percentage.

3.3 Conclusion

The present results show that only a small proportion of boaters can accurately estimate their boat's weight capacity. For example, 63% of the boaters in the present sample over or under estimated their boat's capacity by more than 50 lb (22.7 kg). Boaters' estimates of the maximum horsepower for their boats also left much to be desired. Nearly 25% of the boaters polled could not estimate their boat's maximum power with an error or less than five horsepower. These results suggest that the present capacity labels are not effective devices for communicating weight and horsepower limits to boaters.

The ineffectiveness of capacity labels could be due in part to their placement. However, the present results showed that 91.7% of the boaters who had capacity plates knew where the plate was located. This finding suggests that it is at least partially the design of the plate, not solely its location, which is at fault.

The results of this study strongly suggest that a re-evaluation of capacity plate design and placement and their effect on boaters' behavior is urgently needed. Subtasks 2 and 3 of the present project will address these problems.

4.0 SUBTASK II -- SELECTION AND EVALUATION OF NEW CAPACITY PLATE DESIGNS -- STUDY 2

4.1 Background

This phase of the Labeling Effectiveness project deals with exploring boaters' evaluations of nine alternative designs for presentation of capacity plate information. The designs were developed by Robert MacNeill in an earlier Wyle Laboratories report in which he explored guidelines for presenting labeling information (Reference 2). The principle recommendations specified by MacNeill for presentation of capacity information are as follows:

1. The capacity recommendation should be located on the control station console.
2. The overall size of the capacity plate should be small; letter size should vary according to relative importance of information (larger items for more important information).
3. The content of the capacity plate should include only capacity relevant information. At the most, this would consist of weight capacity for occupants, gear, and motor; weight capacity for occupants only; maximum outboard motor horsepower; manufacturer of the boat; and model of the boat.
4. The additional information suggested for capacity labels in Code of General Regulations (33 CFR 183.25 and 181.15) should be given on a separate label. The intent of information on the second label would be to offer official certification of the boat rather than to achieve boaters' compliance with safe loading recommendations.
5. There should be a "center of interest" in the design in which the essential recommendations are presented.
6. The colors for the design should consist of yellow for the center of interest with black lettering and numbers. Yellow is recommended because it is customarily associated with cautionary situations; red tends to be associated with danger situations.

MacNeill developed and presented in the report nine capacity plate designs that incorporated the recommended revisions. Each of the newer designs were intended

to be simplified or streamlined alternatives to the BIA capacity plates now in use. Capacity information actually required by the U. S. Coast Guard is for total combined weight of occupants, accessories and motor, and maximum horsepower for the motor. The nine presentations included the following variations in design: 1) three alternative pictorializations of the boat, its occupants, and its motor; 2) three alternative ways of enclosing the numerical and verbal capacity information; and 3) three alternative ways of indicating weight capacity information, i.e., total weight only (including occupants and motor/accessories), occupant weight and total weight given separately, and number of occupants at 150 lb (68 kg) each, and motor/accessory weight given separately.

The designs using pictorialization of capacity plate information were intended to offer attention-getting effects as well as providing some redundancy of the verbal and numerical information. The use of pictorialization brings to mind the old Chinese proverb that "a picture is worth a thousand words." However, impressions created by the use of pictorialization might be inconsistent with the overall desired effect of the capacity plate. For example, the pictorialized capacity plate design might present a distraction from the information that is most important; or the picture itself (necessarily in cartoon format) could detract from the authenticity, and cause the boat operator to doubt the accuracy or legality of the information. There was need to weigh the positive and negative implications of pictorialization accordingly (see Designs R, S, and W on foldout in Appendix A).

The use of multiple enclosures (yellow with black outlines) for framing the numerical and verbal capacity recommendations was explored for its potential effects. Either one capacity recommendation was presented alone in a single lengthwise yellow enclosure, or one enclosure for all capacity information was used (see Designs T, U, and V). It was predicted that the use of more than one box for the recommendation would tend to isolate that information from other information on the capacity plate. However, it was not known whether this break-up of the information would have destructive effects to the attractiveness or preferability of the presentation. If the use of enclosures, one way or another, detracted from the information, it is likely that there would be less readership (attention and reading) of the capacity plate design.

The various breakdowns in weight capacities were intended to provide varying degrees of ease for a boater's analysis and interpretation of his own boat loading (see Designs Q, X, and Y). The use of specific weight capacities may, in fact, facilitate interpretation of one's own loading problems, but they also offer possible areas of confusion when an actual load of persons or gear varied in proportion from the weights specified on the capacity label. It is likely that confusion on the part of a boater would either increase the possibility of ignoring the capacity plate information or, at best, create extra effort in order to correctly interpret the limits of capacity plates for his special loading problem. Boaters' impressions were necessary here to assess the effects of the different breakdowns of capacity information.

Comparisons were made for the evaluation of the designs according to the attractiveness of each design, the efficiency of expression of capacity information for each design, the authenticity of the capacity information (that the information is accurate and true), and the "preference" for one design over all others. It is assumed for this evaluation that more highly valued designs for attractiveness, simplicity, and authenticity, and higher frequencies of preference are indicative of designs more likely to be noticed, read, and understood by the general population of boaters.

4.2 Method

4.2.1 Respondents for the Evaluation

Twenty-one persons (twenty males and one female) completed the evaluation of the capacity plate designs. They were recruited from one marina and one launch ramp in the Guntersville Lake, Alabama, area, and from the Huntsville, Alabama, facility of Wyle Laboratories. Criterion for their invitation to participate was that they presently own a boat within the size range requiring a capacity plate to be installed by manufacturers, or had owned a boat of that size in the past year. Respondents were told of the true purpose of the study, that Wyle was evaluating new capacity plate designs for the Coast Guard and that boaters' opinions were required in order to predict how the various designs would be received by the public.

Age of the respondents who consented to help ranged from twenty years to fifty-two years with the median age being thirty-two years. Fourteen (67%) of the respondents reported boating experience less than 100 hours; the remaining six respondents reported experience between 100 and 500 hours. With rare exception, the respondents used their boats for more than one kind of recreational activity; during the questioning most respondents mentioned the combinations of cruising and waterskiing as the primary use of their boats. One respondent "sailed" only, and one respondent was a canoeist. Two persons who initially consented to participate at Guntersville Lake did not finish the evaluations when they learned of the concentration required to make the ratings. This latter data is not included in the analysis.

4.2.2 Materials for the Evaluation

The nine capacity plate designs for rating were prepared so that they were the actual size of the intended capacity plates. These ranged from 13 mm by 63 mm to 17 mm by 70 mm in size. The designs were "developed" and "printed" on photo sensitive card stock; transparent yellow adhesive film was then placed over the colored portions of the design; and the numbers and letters added using headliner type. The finished design was laminated in clear plastic. The end result was a durable plastic card for each design that could be readily handled by researchers and respondents without damage or any evidence of prior use. The capacity recommendations for all nine capacity plate designs were identical: three persons limitation, total weight allowable was 610 lb (276.7 kg), and 70 maximum horsepower.

The actual evaluation of the designs was conducted using a large rating board constructed for that purpose (22 in. by 64 in. [55.9 cm by 162.6 cm]), masonite with light green "Marlite" surface). This procedure was preferred as a more "interesting task' over the obvious alternative, the questionnaire or paper-pencil test. Since the total number of required ratings was relatively high; i.e., twenty-seven (nine capacity plate designs each rated for attractiveness, simplicity, and authenticity), it was believed that respondents' interest and motivation would remain higher using the rating board. The board was mounted horizontally on a sturdy wood frame, and was inclined about twenty degrees. Four rating scales of the "line - blank space -line" type were arranged across the full width of the board. Each

scale consisted of nine positions (lines on which judgments of the capacity plate designs could be made). Each line of the scales was actually a four inch (10.2 cm) length of one-half inch (1.3 cm) "quarter-round" wood stock painted black. This enabled respondents to place the capacity plate designs on the board while it was in the inclined position to indicate their rating. At each end of the scales, opposite word/phrases corresponding to the dimensions for judgment (least attractive - most attractive, etc.) were positioned to provide the polarity for each side of the scale. The word/phrases were printed on three inch by five inch (7.5 cm by 12.7 cm) cards and also laminated in plastic. They were positioned on additional "quarter-round" stock to enable the researchers to turn the printed side over when that particular scale was not in use. The first scale (top-most position) was used for demonstration by researchers to the respondents on how to make ratings on the board. The remaining three scales were the criteria scales: attractiveness, simplicity, and authenticity, respectively. (See Figures 4 and 5 for photographs of the rating board. See Appendix B for dimensions of the rating board.)

4.2.3 Administration of the Evaluation

Evaluations of the capacity plate designs were conducted in the Wyle GMC van at the Guntersville Lake location, and in an unused office at the Wyle Huntsville Facility. The rating board was set up inside the van for the Guntersville respondents in order to minimize visual distractions at the marina and launch ramp, and to provide equitable conditions for each of the respondents to make their ratings. The first respondent to participate in the evaluation was quizzed extensively after his evaluations of the designs to determine if the instructions read by researchers were clear and that the task of rating was being undertaken as intended by the research design. The instructions to respondents were shortened as a result of the comments made by the "pilot" respondent, and subsequent administrations of the evaluation went more smoothly. The pilot respondent's data were included with the analysis of the rating data, since it offered no apparent departure from opinions expressed by later respondents who received the revised form of the instructions.

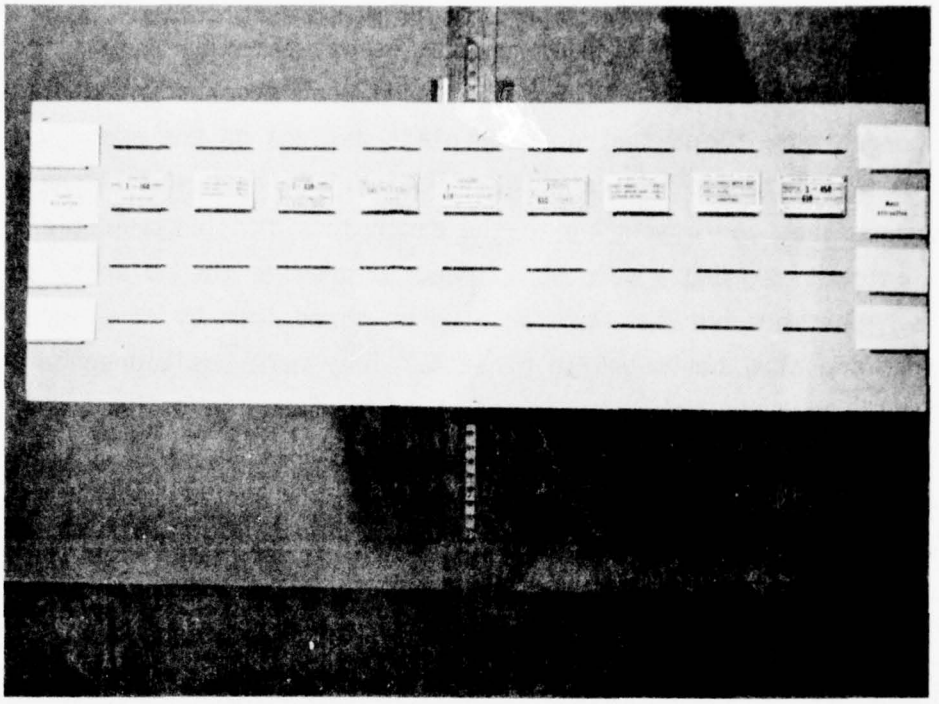


FIGURE 4. RATING BOARD FOR EVALUATION OF NEW CAPACITY PLATE DESIGNS

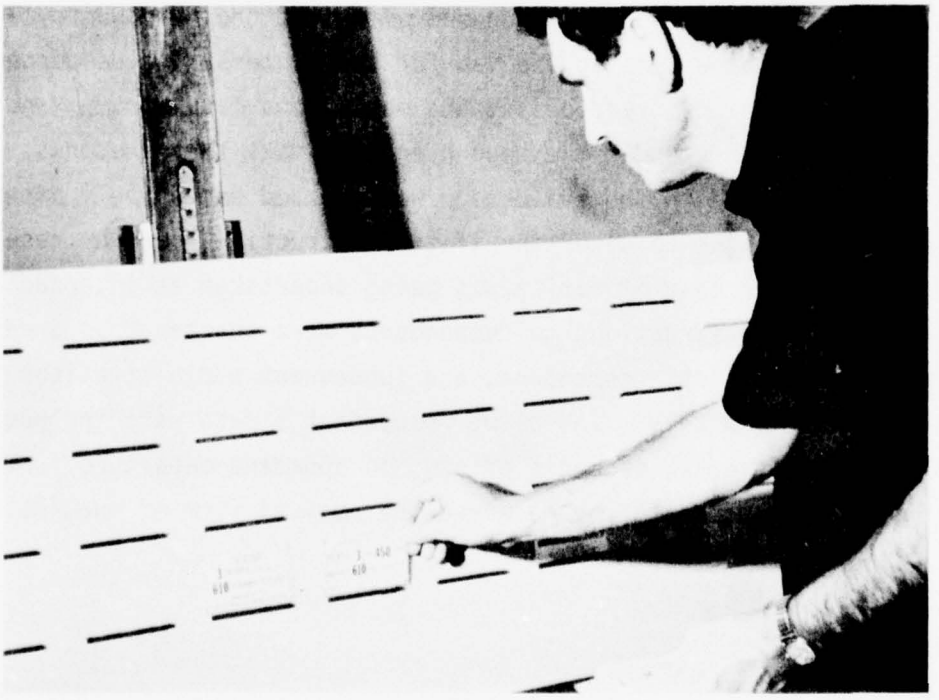


FIGURE 5. RESPONDENT MAKING RATINGS ON AUTHENTICITY DIMENSION OF THE RATING BOARD

The evaluation of the capacity plate designs called for a two phase procedure for administration. Instructions given to respondents were read or repeated from memory. A copy of the instructions is in Appendix C. Respondents were first asked to rate the capacity plates. They were told that each of the capacity plates contained the same capacity information, but the way the information was presented varied, i. e., the capacity plates could all have been applied to the same small boat. When respondents completed their ratings on each dimension, they gave researchers their reasons for rating the designs in the extreme high and low rated positions. When the rating phase was completed, the researcher began a brief interview. Respondents were asked to choose from the alternative designs the "one design that they would prefer to have mounted on their own boat." Respondents then were asked to give their age, the primary use(s) for their boat, and the amount of experience (in hours) they had as the operator of a boat. The evaluation session was terminated at the end of the questioning; the sex of the respondent was recorded by the researcher. The data form for recording respondents' ratings and answers is presented in Appendix D.

4.3 Results

4.3.1 Measurement and Analysis

The outcome of the evaluations of the various capacity plate designs was based upon three criterion responses: 1) ratings for each of the nine capacity plate designs on attractiveness, simplicity, and authenticity, 2) comments made by respondents regarding their most extreme ratings on high and low ends of the rating scales, and 3) specified preferences for one capacity plate design over all other designs.

Evaluations made by respondents on the rating scales were scored in the following manner. Each of the spaces on the rating scales had a numerical value. Any capacity plate design could receive a rating that ranged from 1 to 9. For a rating given in the extreme low position of the scales (least attractive, least simple and efficient, and least authentic, the value of 1 was recorded for that capacity plate design. For a rating given in the extreme high position of the scales (most attractive, most simple and efficient, and most authentic), the value of 9 was recorded for that capacity plate design.

Descriptive statistics were computed to determine the average rating (arithmetic mean) given for each design, and to determine the relative variability (standard deviation) of ratings given for each design. Arithmetic means were computed by summing the ratings for each capacity plate design and dividing that number by the total number of raters. Variability of the ratings for each design was determined by computing the formula for standard deviations for each array of ratings given on each scale for the respective design.

Comments made by respondents regarding their lowest and highest rating on the attractive, simple and efficient, and authentic evaluations were grouped according to identical or similar key words. For example, one respondent's reference to "omission of USCG" from one particular design, and another respondent's reference to "should have Coast Guard on the top" were grouped in a "no mention of USCG" category.

Preferences for the capacity plate designs were summarized using a distribution of frequencies for the "most preferred" design. Chi Square statistical techniques were used to determine if selections for preferred capacity plate designs tended to be random over all nine alternatives or whether the preferences favored one or more of the alternatives.

Classification data for the respondents' age, hours of boat operating experience, and primary use of their boat were listed to characterize the respondents as a group.

4.3.2 Ratings of Attractiveness of the Capacity Plate Designs

The results of the evaluation of the capacity plate designs is presented in this section. The implications of the results for the three general principles underlying the designs (such as use of pictorialization) are discussed in the recommendation section.

Average ratings for the attractiveness of the capacity plate designs ranged from 6.14 for the most attractive to 4.29 for the least attractive. Standard deviation (SD) values ranged from 2.15 to 3.16. Two capacity plate designs, Design Q and

Design T, received 6.14 average ratings. Four respondents rated Design Q as the most attractive (rating of 9); five respondents rated Design T as the most attractive. Design X was rated as least attractive of the nine designs ($\overline{X}$ = 4.29). Comparisons of the variability of the ratings for each of the two designs rated as most attractive indicates that Design Q had the lowest variability (or the greatest stability) of ratings for any designs judged (SD = 2.15); variability for Design T is slightly higher (SD = 2.50). Arithmetic means and standard deviations for the capacity plate designs are presented in Table 6.

TABLE 6. ARITHMETIC MEAN RATINGS ($\overline{X}$) AND STANDARD DEVIATIONS (SD) FOR ATTRACTIVENESS OF CAPACITY PLATE DESIGNS (IN DECENDING ORDER OF MEAN RATINGS)

	Q	T	U	W	Y	S	R	V	X
$\overline{X}$	6.14	6.14	5.33	5.05	5.00	4.90	4.76	4.76	4.29
SD	2.15	2.50	2.80	2.82	2.36	2.30	3.16	2.86	2.22

Comments made by respondents concerning the reasons why they rated Designs Q and T as the most attractive designs include the following:

Design Q: "...precise, clear lines, not busy, self-explanatory, all relevant information is there."

Design T: "...boldness of print, straight forward, easy to get information, individualizes, things are proportional and equal."

Comments concerning the reasons Design X was rated as the least attractive include: "...more difficult to understand, difficult to read, lacks information, too simple, 160 lb (72.6 kg) means nothing."

4.3.3 Ratings of Simplicity and Efficiency of the Capacity Plate Designs

Average ratings for the simplicity and efficiency of the capacity plate designs ranged from 6.33 for the most simple and efficient to 4.14 for the least simple and efficient design. SD ranged from 1.73 to 3.00. Design T received the highest average rating for simplicity and efficiency; Design R received the lowest average

rating. Design Q ranked second in the simplicity ratings ($\overline{X}$ = 5.95; SD = 1.96). Design Y, rated by respondents as the third most simple and efficient design ($\overline{X}$ = 5.90), received the more stable ratings judged by the lowest standard deviation on the simplicity dimension. There may be no reason to rank Designs Q and Y differently.

See Table 7 for the mean ratings of simplicity and standard deviations of those ratings for the evaluated capacity plate designs.

TABLE 7. ARITHMETIC MEAN RATINGS ($\overline{X}$) AND STANDARD DEVIATIONS (SD) FOR SIMPLICITY AND EFFICIENCY OF CAPACITY PLATE DESIGNS (IN DECENDING ORDER OF MEAN RATINGS) NOTE: HIGHER RATINGS ARE GIVEN FOR MOST SIMPLE DIRECTION

	T	Q	Y	U	V	S	W	X	R
$\overline{X}$	6.33	5.95	5.90	5.29	5.10	4.86	4.76	4.43	4.14
SD	2.74	1.96	1.73	2.74	3.00	2.52	2.91	2.04	2.85

Comments concerning the "most" and "least" simplicity choices are as follows:

Design T: "...rows used for information, separation, maximum weight first, breakdowns in terms of people, to the point."

Design Q: "...[large] size of print and numbers, points out information easiest, boldness, stands out."

Design Y: (Not selected as the least or most simple and efficient design.)

Selected comments concerning the reasons Design R was rated as least simple and efficient include: "...too busy, too much on plate, more difficult to figure up capacities, cluttered, small print, must search for information."

4.3.4 Ratings of Authenticity of the Capacity Plate Designs

Average ratings for authenticity of the capacity plate designs ranged from 6.81 for the most authentic and believable design to 3.67 for the least authentic design. Designs U and T received the highest average ratings for authenticity with means of 6.81 and 6.71, respectively. Design Q was rated just above the

midpoint of the scale ($\overline{X}$ = 5.62). The least authentic design was Design S, ($\overline{X}$ = 3.67). Standard deviations ranged from 2.80 for Design S to 1.73 for Design Y. Designs U and T were 2.11 and 2.49, respectively. See Table 8 for the mean and standard deviations of ratings of authenticity for the capacity plate designs.

TABLE 8. ARITHMETIC MEAN RATINGS ($\overline{X}$) AND STANDARD DEVIATIONS (SD) FOR AUTHENTICITY OF CAPACITY PLATE DESIGNS (IN DECENDING ORDER OF MEAN RATINGS)

	U	T	V	Y	W	Q	R	X	S
$\overline{X}$	6.81	6.71	6.19	6.10	5.67	5.62	5.33	4.86	3.67
SD	2.11	2.49	2.36	1.73	2.56	2.22	2.75	2.43	2.80

Comments concerning respondents' reasons for the ratings as most authentic and believable designs are as follows:

Design U: "...U. S. Coast Guard [endorsed], factual presentation, data only [is] presented, official size, smaller print at bottom makes it look official."

Design T: "...boldness, order of information [appears official], straight forward, small print at bottom, serious, easy to see [relevant information]."

Design Q: "...easy to figure...out [capacities], states 'maximum capacities'."

Comments concerning respondents' reasons for rating Design S as least authentic include: "...no mention of U. S. Coast Guard (expressed by six respondents), cartoon, like telling a story, doesn't say capacity anywhere." See Appendix E for a complete listing of comments for each of the capacity plate designs.

4.3.5 Preferences for Capacity Plate Designs

Preferences for the capacity plate designs were analyzed for two purposes: to determine if some designs were actually more desirable than other designs for the group of persons in the study, and to determine if the preferences for any given respondent coincided with his high ratings for that design on the attractiveness,

simplicity, and authenticity dimensions (an essential question if these dimensions for ratings are valid predictors of respondents' overall judgment of the designs).

Tallies of frequencies for the most preferred capacity plate designs indicate that the majority of the respondents preferred Design T. Eight of the twenty-one respondents selected Design T for the "hypothetical installation on their boat." Designs Q, R, and U were each selected by three respondents. No respondent preferred Designs X and Y. Chi Square computations to determine if the preferences were likely to be systematic rather than a random outcome of choices support the systematic interpretation ($\chi^2 = 20.60$, $df = 8$, $p \leq 0.05$). Frequencies of preferences for each capacity plate design are presented in Table 9.

TABLE 9. SELECTED CAPACITY PLATES IN DECENDING ORDER OF PREFERENCE

Capacity Plate Design	Frequency of Preference
Design T	8
Design Q	3
Design U	3
Design R	3
Design W	2
Design S	1
Design V	1
Design X	0
Design Y	0

It would seem interesting to determine if preferences for given capacity plate designs were suggested by trends in the ratings for each of the dimensions reported earlier. In fact, the preferred capacity plate designs tended to be rated above the mid-point of each of the rating scales. Nineteen respondents selected capacity plate designs as "most preferred" that were rated above the mid-point of the attractiveness and authenticity dimensions. Eighteen respondents selected capacity plate designs as "most preferred" that they rated above the mid-point of the simplicity dimension. Chi Square analyses of the three comparions of preferences and ratings above and below the mid-points of the rating scales indicate that the

comparisons are statistically significant ($\chi^2 = 13.76$, df = 1, $p < 0.05$; $\chi^2 = 10.71$, df = 1, $p < 0.05$).

4.3.6 Cross Tabulations of Capacity Plate Design Preferences and Respondent Characteristics

Cross tabulations of capacity plate design preferences and two characteristics of the respondents were undertaken to determine possible associations between preference and the respondents. Cross tabulations were for the primary uses given for the boats owned by respondents and the respondents' boating experience. The tabulations for capacity plate preferences and the four possible boat uses indicate that concentrations of capacity plate design preferences are somewhat randomly distributed across the various boat uses. That is, the preferred capacity plate design selected by respondents does not appear to be related to the primary uses given for the boats. A summary of the tabulations is presented in Table 10. The number of entries (frequencies) does not equal the number of respondents since each respondent was free to indicate more than one use for his boat.

TABLE 10. CROSS TABULATION OF DESIGN PREFERENCES AND BOAT USES

Designs	Cruising	Waterskiing	Fishing	Other
Q	3	2	2	1
R	2	3	2	1
S	-	1	1	-
T	2	4	4	2
U	2	2	-	1
V	1	1	-	-
W	1	1	2	-
X	-	-	-	-
Y	-	-	-	-
Totals	11	14	11	5

There is some suggestion of association between hours of experience as operator of a boat and certain preferred capacity plate designs. All three respondents who preferred Designs Q and R were among the most experienced boat operators. Design T was preferred equally (four respondents each) by respondents in the most experienced and moderate experience (100-500 hour) classifications. Of the three respondents preferring Design U, one respondent each reported 20-100 hours, 101-500

hours, and over 500 hours. Tabulations for capacity plate design preferences and hours of boat operator experience are presented in Table 11.

TABLE 11. CROSS TABULATION OF BOAT EXPERIENCE AND CAPACITY PLATE DESIGN PREFERENCE

Design	Less Than 20 Hrs	20-100 Hrs	101-500 Hrs	Greater Than 500 Hrs
Q	-	-	-	3
R	-	-	-	3
S	-	-	-	1
T	-	-	4	4
U	-	1	1	1
V	-	-	-	1
W	-	-	1	1
X	-	-	-	-
Y	-	-	-	-
TOTALS	-	1	6	14

4.4 Recommendations Concerning Capacity Plate Designs

Three recommendations for the design of capacity plates for recreational boats can be made as a result of this research effort. The recommendations can be taken as guidelines for the selection of capacity plate designs for additional evaluation.

1. Pictorialization of information does not necessarily increase the extent to which persons aesthetically value the capacity plate, nor does it increase preferability among persons given other non-pictorialized alternatives. The three capacity plate designs having pictorialized information in this research received lower ratings for attractiveness, simplicity, and authenticity than did non-pictorialized designs in general. Comments for the extreme authenticity ratings offer some explanation since the pictorialization was frequently referred to as a "cartoon." The preference for Design R by three respondents cannot be explained in this research beyond pure speculation. It may be that the flotation theme featured in the design (omitted from all other designs) caused the reaction in its favor. It should be noted that no mention was made of this characteristic in the comments given by respondents.

2. The use of multiple enclosures for each type of capacity information seems to be a characteristic valued aesthetically by boaters. Design T was highly valued on all three dimensions for rating in the study, and was selected as the preferred design by the largest number of respondents. The information given in Design T was identical to that given on Designs Q, U, and V. It should be noted, however, that letter size and boldness were somewhat larger for the preferred Design T than for Design V; and that the numerical information preceded the verbal information for Design T.

3. The weight capacity should be clearly defined for total weight and for occupant weight. In effect, the presentation should facilitate the analysis of one's own boating load with respect to occupants. Designs Q, T, and U were valued in no lower than the fourth highest ratings (U was rated fourth highest on the simplicity dimension). In addition, the three designs were preferred by fourteen respondents (67%) in this project. Designs R, S, and X were each valued fairly consistently in the lower ratings, and none presented information for occupant weight separately from total weight (see Tables 6, 7, and 8 for mean ratings). Comments explaining respondents' higher ratings for Designs Q, T, and U support an interpretation that the latter three designs made understanding the capacity limits more difficult.

5.0 SUBTASK II -- SELECTION AND EVALUATION OF NEW CAPACITY PLATE DESIGNS -- STUDY 3

5.1 Background

The intent of the capacity plate label effectiveness project is to deal with characteristics of boat capacity design relevant to comprehension of the capacity information. Specifically, the investigation will determine the relative facilitation of comprehension of the capacity information for three variations of the new capacity plate designs. A BIA capacity plate currently in use was included in the testing (to evaluate the potential) for improvement of comprehension effects using the newer designs).

The designs tested in this phase of the project and the rationale concerning their development and selection are as follows:

- Use of multiple enclosures for isolating each capacity recommendation, or use of one enclosure for all capacity recommendations;
- Use of pictorialization as an adjunct to the capacity recommendations, or presentation of capacity recommendations without pictorialization;
- Use of tabulated order of numerical and verbal information; i.e., verbal first and numerical second ("Weight 937 lbs") or typical order of numerical and verbal information in sentence contexts; i.e., numerical first and verbal second ("937 lbs Weight"). See foldout of designs in Appendix F.

The rationale for testing these particular designs is based upon two sources: from comments and ratings given to the capacity plate designs in the previous study in this subtask, and from previous research findings at Wyle. The technique of presenting each capacity recommendation within a separate enclosure (multiple enclosures) resulted largely from aesthetic considerations. Boat owners rated this type of design very favorably on characteristics of attractiveness, simplicity, and authenticity in Study 2 of this evaluation. However, it was not known if comprehension of the information might actually be made more difficult when additional visual cues (in this case multiple enclosures for capacity recommendations) were

presented on the capacity plate. Persons viewing the capacity plate design might need to "sort out" the capacity recommendations from the technique used to emphasize the information, and consequently require more effort or time to comprehend the information. A comparison of comprehension of information presented within a multiple enclosures design to identical information presented within a single enclosure design was made in the present study.

The use of pictorialization as an adjunct to the capacity recommendations produced mixed reactions on the part of boaters' ratings in Study 2. Pictorialized designs in the previous study included occupants (the same number pictured as recommended for boat capacity) riding in a boat; and occupants wearing PFDs, sitting in a swamped boat. Ratings given for these designs were in general lower on the aesthetic dimensions than non-pictorialized designs. However, it should be noted that the ratings given by three boaters contrasted sharply with the general trends when they rated Design R as most authentic of the alternative designs. In another study conducted at Wyle (Reference 3) pictorialization produced equally inconsistent results. Persons recruited for the experiment (Reference 3) were asked to ride in a boat and "view visual distress signals provided on shore" by Wyle researchers. When the boat was "intentionally swamped" for the true purpose of the experiment, several boaters complied with a label mounted in the boat giving the instructions to remain with the boat. The label contained a vivid pictorialization of persons sitting on the bottom of a swamped boat in addition to the verbal instructions. However, no boaters recalled seeing the pictorialized information on the label even when they had read and complied with the verbal instructions. The pictorialized designs in both previous studies were anticipated to have a "novelty effect" that would at the very least increase the likelihood of their being noticed. A comparison of comprehension of the pictorialized designs was made with non-pictorialized designs having identical capacity information in the present study.

The presentation of numerical and verbal information in alternative orders resulted entirely from comments given by boaters in Study 2. Comments given during the ratings (some unsolicited by researchers) and comments given after the ratings suggested that this kind of order effect significantly influenced "preferences" for one design over another. For example, Design Q was rated very highly by

boaters, but elicited several objections to the verbal identification of the capacity being presented before the actual numbers. This variation of presentation was tested in the present study to determine if one ordering of the capacity recommendation was superior in facilitating comprehension of the information than the other ordering. It was reasoned that the comprehension differences (if they could be detected and measured) would possibly result from the higher expectation of numerical information preceding the verbal information as in a modifier function in typical English sentence structure.

5.2 Operational Definition for Comprehension

This project was concerned with the communication of capacity information to boat owners and operators, and the process of comprehension of information was considered essential before any communication could take place. In order to determine how various capacity plate designs affected comprehension, it was necessary to specify exactly what characterized the comprehension process. Dictionary definitions identified the term comprehension as the synonym for understanding, and vice versa. However, the dictionary definitions required refinement for systematic research purposes (as is usually the case). Note that comprehension is a subjective event that is experienced on the part of the sensing person, and that it is impossible to reliably see when a person precisely comprehends something. Operational definition was necessary to enable systematic confirmation of the occurrence of comprehension. For this study, comprehension was confirmed when a person verbally reported an accurate distinction between identical and non-identical information in an experimental task. It was assumed that comprehension of information (or a basic understanding) was prerequisite to persons recognizing and identifying various boat capacitites presented on the alternative capacity plate designs.

5.3 Method

5.3.1 Review of General Procedure and Rationale for Method

The capacity plate designs were presented using a tachistoscopic technique and a "match to sample" procedure for administration. The tachistoscopic presentation of the designs displayed each design momentarily on a projection screen. The task for the "match to sample" procedure involved the non-tachistoscopic display on the projection screen of each design while persons wrote down the capacity information on paper. Then identical designs were shown tachistoscopically. After each tachistoscopic presentation of a design, persons were asked to identify the capacity information on the design as the same or different from that information on the initial display. Two of the six displays presented tachistoscopically actually contained the same capacity information as the initial display while four contained different capacity information.

Conditions for presentation of the capacity plate designs required three special considerations in order to validly compare the variations of designs. First, designs to be compared had to be viewed for exactly the same length of time, i.e., there had to be the same amount of time to recognize the capacity information. Any differences that occurred in the more accurate recognition of information in the designs were then attributable to the design characteristics themselves and not to the amount of viewing time. Tachistoscopic techniques were considered adequate for control of the viewing time for each display since the number of exposures and durations of exposure times could be controlled exactly for each design. Second, the methods of presentation had to be sensitive to probable small differences in recognition likely to be produced by the variations in capacity plate designs. The marginal perception conditions produced by the tachistoscopic displays were actually less than a person needed in order to completely identify all elements of the complete design being displayed. Measurement of the differences in recognition was then dependent upon the rate at which the information could be recognized from a constant interval of display time. The more information correctly recognized from the display, the faster the information had to be recognized (and the better that capacity plate design being shown facilitated recognition).

The third consideration for presentation of the capacity plate designs was to minimize the effects of the different "viewing strategies" employed by persons viewing the tachistoscopic displays. Since the designs were a complex array of lines, forms, enclosures, words, and numbers, a person could direct his attention to one of several possible alternatives for each exposure. Consider the person who quickly learns to focus his attention on a different element of the display for each subsequent exposure of a design having the same capacity information. He will eventually form an accurate composite of the recognized elements presented for very brief durations. Another person may choose to attempt identification of the entire display as a whole with each exposure, and consequently may never recognize the information given in the display for the same duration of exposure as the first person. Differences in recognition in a valid test of the capacity plate designs needed to result from "facilitating characteristics of the designs and not from different viewing strategies. The "match to sample" procedure was intended to minimize the effects of alternative methods of viewing by requiring identification of the capacity information after each exposure. In this task persons had to focus attention on about the same position for each tachistoscopic display (the position in which the capacity information appeared) in order to identify correctly whether the information was the same or different from the initial display.

5.3.2 Administration

The capacity plate designs were presented to 22 Wyle employees who either owned a boat less than 26 ft (7.9 m) in length, or regularly operated a boat within that size. They were randomly assigned to two groups consisting of 11 persons each. Group One was shown the following designs: multiple enclosures design, non-pictorialized design, and verbal/numberical order of information design. Group Two was shown the alternative variations of the designs as follows: single enclosures for the same capacity information included in the multiple enclosures design; pictorialization for the same capacity information included in the non-pictorialized design, and numerical/verbal order of information for the same capacity information included in the verbal/numerical design. Both groups received the same BIA capacity plate design.

The order in which the four designs were shown was systematically varied in order to eliminate the probable effects of practice (the designs presented later in the sequence should normally have better recognition as a result of participants' learning the task and refining their expectations of the speed at which the displays were to be presented). The first persons in Group One and Group Two received the order of designs as indicated above (ABCD). The second person in each group received the reverse order of the designs (DCBA). The third person in each group received a CDAB order, and the fourth person received a BADC order. The first order of presentation of designs was continued for the fifth person and so on until 11 persons in each group were tested.

The capacity plate designs were presented using a Lafayette tachistoscope, number 43016, fitted on a Kodak Carousel 800 Series 35 mm slide projector. This tachistoscope will present slides on a projection screen for durations ranging from 150th of a second to two seconds. The slides were shown in a darkened room on a Da-lite projection screen using the standard 500 watt lamp in the projector. The projector was located 68 in. (1.7 m) from the screen so capacity number height varied from 1/2 in. (1.3 cm) for the BIA capacity plate, to 5/8 in. (1.5 cm) for the multiple enclosures/single enclosure design, to 1-1/8 in. (2.9 cm) for both pictorialization/non-pictorialization, and numerical-verbal order designs. In order to compensate for the different number sizes, the time interval for viewing was lengthened for the smaller BIA and enclosure designs to 1/10 of a second; the larger sized number designs were viewed for intervals of 1/25 of a second.

The durations of display time (1/10 sec. and 1/25 sec.) were determined using three persons (familiar with boating) who viewed the series of designs solely for calibration purposes. The criterion for selection of the display times was the correct identification of the information on at least one exposure of a design and less than perfect identification of the information on all exposures of a design. The slides were viewed for all persons in the study at 65 in. (1.7 m) from the projection screen (however, three subjects did lean forward in their chairs during the presentations).

Administration of the matching task began after participants had adapted to the darkened room, and had received a brief series of warm-up slides. As soon as participants were seated in front of the projection screen, the room was darkened,

and the instructions were read aloud by the researcher (using a flashlight). The warm-up sequence of slides consisted of seven tachistoscopic presentations at exposure speeds ranging from 1/150 of a second to 1/50 of a second. The content of the warm-up slides was unrelated to boating, and seven presentations appeared to be adequate for acquainting participants with the tachistoscopic displays. When participants had no further questions on the task or on the methods of design presentation, the appropriate test carousel magazine was loaded on the projector and the matching task begun. Time for the complete administration of the experimental procedure averaged 12 minutes. A copy of the instructions read to participants is presented in Appendix G.

5.3.3 Preparation of the Capacity Plate Slides

The Wyle illustrator and the photo-reproduction staff prepared a series of seven slides for each capacity plate design. The series for each design consisted of three slides having identical capacity information and four slides having different capacity information. One of the identical three slides was the initial viewing slide; the remaining two identical slides were embedded randomly in the administration sequence with the four dissimilar slides. The number of slides prepared for the experiment was 29 for each group of participants; i.e., seven slides for each new capacity plate design, and eight slides for the BIA design (the BIA design was shown with one practice exposure at the start of the tachistoscopic presentation - a fact unknown to participants since all of their responses were tallied).

Particular care was taken in the preparation of each slide so that all capacity information always appeared in exactly the same position on the slides for any given design, and for the alternative design which was shown to the other group of subjects. In addition, the dimensions, borders, figures, and colored areas were identical for each slide in the series. Where relevant, the alternative design dimensions were identical; e.g., the outer dimensions of the yellow single enclosure design corresponded to the outer dimensions of the combined three enclosures in the multiple enclosures design.

Numbers selected for the capacity information were entirely fictitious, although they appeared quite plausible. The numbers were generated using a modified random

numbers procedure. "Total weight" capacity information was a series of three digit numbers beginning with 7, 8, or 9. "Occupant weight" capacity information was a series of three digit numbers beginning with 4, 5, or 6. "Horsepower" capacity information was a series of three digit numbers beginning with either 1 or 2 and always ending with a 0. This procedure resulted in four sets of numbers used as capacity information for the three new designs and their alternatives, and for the BIA design.

5.4 Results

5.4.1 Measurement and Analysis

The results of the capacity plate designs shown to participants in the study were based upon the frequency of correct recognitions of the capacity information in each series of slides. A correct recognition was recorded in either of two ways: when a participant reported the information as the same as the initial slide of the series and it actually was the same, or when a participant reported the information as different from the initial slide and it actually was different. For each series of slides for a given design, a participant's score could range from (0) for no correct recognitions to (6) for correct recognitions for all slides in the series.

Recognition scores for the capacity plate designs shown to Group One were compared to the scores of the alternative designs shown to Group Two. Comparisons between overall design types (e.g., the multiple enclosures design with the pictorial design) were not formally planned unless the data suggested the analysis. Planned comparisons were not attempted because the dimensions of the capacity numbers used for criterion recognitions on the various designs varied by 1/2 in. (1.3 cm) in height when projected on the screen, and the exposure times given to participants had to be longer for the smaller sized numbers to compensate for recognition difficulty. The BIA design was evaluated by comparison of the arithmetic mean of the BIA recognition scores to the averaged arithmetic means of the three newer designs.

Analyses to determine statistical significance of differences between design alternatives include: t-tests for independent samples for analysis of the means of

the new designs, Kolmogorov-Smirnov tests for analysis of the distribution of scores for the new designs*, and one t-test for repeated measures for analysis of the BIA design and the combined means of the new designs.

5.4.2 Multiple Enclosures and Single Enclosure for Capacity Plate Designs

The single enclosure design produced recognition scores slightly higher than the multiple enclosures design for participants in this study. Correct recognition scores for the single enclosure design ranged from 4 to 6 with a mean (average) value of 5.455. Correct recognition scores for the multiple enclosures design ranged from 1 to 6 with a mean value of 4.818. Seven persons (64% of Group Two) correctly identified all of the slides in the single enclosure series. Four persons (36% of Group One) correctly identified all of the slides in the multiple enclosures series.

Computation of t for the difference between the mean recognition scores for the two designs was not statistically significant ($t = 1.213$, $df = 20$, $p > 0.05$). In order for the computed t to be significant at the 0.05 level using a two tailed test, t had to be equal to or greater than 2.086. Comparisons of the two distributions of recognition scores were made for each design and were tested for statistical significance using the Kolmogorov-Smirnov test ($K_D = 3$, $N = 22$, $p > 0.05$). In order for K_D to be significant at the 0.05 level of confidence, the calculated value had to be equal to or greater than 7 for a two tailed test. The difference between the distribution of frequencies for the score values for the single enclosure design and the distribution for the multiple enclosures design was not statistically significant.

---

* The Kolmogorov-Smirnov test is intended to detect differences in distributions with regard to central tendency, dispersion, and skewness. The test is discussed in Hays, Wm., Statistics, NY: Holt, Rinehart, and Winston, Inc., 1963, p 753; in Siegel, Sidney, Non-Parametric Statistics For The Behavioral Sciences, NY: McGraw-Hill Book Co., Inc., 1965, pp 127-136; and Williams, F., Reasoning With Statistics, NY, Holt, Rinehart, and Winston, Inc., 1968, pp 119-120.

5.4.3 Pictorialization and Non-Pictorialization For Capacity Plate Designs

There did not appear to be any appreciable difference between recognition scores produced by pictorialized and non-pictorialized designs. Correct recognition scores for the pictorialized design ranged from 5 to 6 with a mean value of 5.455. Correct recognition scores for the non-pictorialized design ranged from 3 to 6 with a mean value of 5.363. Seven persons correctly recognized all of the designs in the non-pictorialized series; six persons correctly recognized all of the designs in the pictorialized series.

Computation of t for the statistical significance of the difference between the mean recognition scores for the two designs was not statistically significant ($t = 0.244$, $df = 20$, $p > 0.05$). Results of the comparison of the distribution of recognition scores for the two designs using the Kolmogorov-Smirnov technique were also not statistically significant ($K_D = 1$, $N = 22$, $p > 0.05$).

5.4.4 Order for Numerical and Verbal Information For Capacity Plate Designs

The design in which numerical capacity information precedes the verbal information produced recognition scores superior to the alternative design (verbal information precedes the numerical information). Evidence of the difference was more supportive than in the previous comparisons. Correct recognition scores for the numerical/verbal design ranged from 3 to 6 with a mean value of 5.182. Correct recognition scores for the verbal/numerical design ranged from 3 to 5 with a mean value of 4.636. Six persons (55% of Group Two) correctly identified all of the designs in the numerical/verbal order series. No one correctly identified all of the designs in the verbal/numerical series.

Computation of t for analysis of the difference between the mean recognition scores for the two designs was not statistically significant ($t = 1.422$, $df = 20$, $p > 0.05$). Chi Square was computed for analysis of the difference between the number of persons correctly identifying all of the designs in the numerical/verbal series and the verbal/numberical series ($\chi^2 = 11.10$, $df = 1$, $p < 0.05$). Although χ^2 was statistically significant, the test remained a comparison of data made

"after the fact." For one degree of freedom, χ^2 had to be equal to or greater than 3.84. Analysis of the different distributions of the recognition scores using the Kolmogorov-Smirnov technique was also statistically significant ($K_D = 11$, $N = 22$, $p < 0.05$). The two distributions of recognition scores apparently differed according to the frequency with which the range of score values occurred for each group.

5.4.5 BIA Capacity Plate Design

The recognition scores for the BIA design were lower in general than the scores for the newer designs. Correct recognition scores for the BIA design ranged from 0 to 6. There was one person who correctly identified all of the designs and one person who did not identify any of the designs. The mean value for the BIA design recognition scores was 3.455 and was based upon the average of all 22 participants in the study. The average of the combined mean scores for the three new designs and the three alternatives was 5.152 correct recognitions.

Computation of t for analysis of the difference between the means of the BIA scores and the combined means for the new designs was statistically significant ($t = 4.611$, $df = 21$, $p < 0.05$). In order for the t for repeated measures to be significant, t had to be equal to or greater than 2.08, using a two tailed test.

5.5 Recommendations

Three recommendations can be made for future selection of capacity plate designs with regard to comprehension of the capacity recommendations.

1) The use of multiple enclosures for emphasizing each capacity recommendation may actually inhibit comprehension of the information. Although the multiple enclosures design may be a preferrable design from the point of view of aesthetics (as suggested in Study 2), this phase of the project suggests caution in its use. It is the opinion of the researchers that if additional persons were shown the multiple and single enclosure design slide series, the subsequent comparisons of the different recognition scores would be statistically significant. It is plausible that the capacity information and the methods used for emphasizing the information are in some way additive. The fewer

accurate recognitions for the multiple enclosure design may have resulted from the additional complexity of the design. At the fixed exposure intervals, the complexity might have been sufficient to reduce the amount of capacity information that could be recognized at the viewers' normal recognition speeds. Additional evaluation of the multiple enclosures/single enclosure comparison is suggested.

2) Numerical information should precede the verbal phrases identifying the capacity information if comprehension rate is to be maximized. Support for the numerical/verbal order is fairly consistent in both phases of this project. Despite the customary use of the tabulated order of information for brevity (e.g., People: 4), there may be stronger or more frequent expectations of information to be presented in the usual order of "good" grammer for sentences. Differences in expectation have been shown to favorably influence recognition scores in other tachistoscopic studies.

3) The use of pictorialization as an adjunct to the capacity information did not seriously inhibit or facilitate comprehension in the test provided in this phase of the project. There were no apparent differences in comprehension between the pictorialized and non-pictorialized designs. Although it was not the purpose of this project to make comparisons between major designs, the following observation was noted. Mean values for the recognition of information for the numerical and verbal order series of 12 slides were greater than the mean values of the 12 slides used for the pictorialization/non-pictorialization series. All four series were shown at the same tachistoscopic speed (1/25 of a second) and criterion number size was identical (1-1/2 in. (3.8 cm) in height). The difference between the means (5.409 - 4.909 = 0.5) was unlikely to be sufficient to reach statistical significance. However, the difference does suggest that comprehension was not facilitated by pictorialization and/or by the arrangement of the capacity information on both pictorialized and non-pictorialized designs. Future testing of pictorialization is not warranted.

6.0 SUBTASK III -- EVALUATION OF NEW CAPACITY PLATE DESIGNS ACCORDING TO ASPECTS OF SAFETY-RELATED BEHAVIOR -- STUDY 4

6.1 Background

The intent of Study 4 was to determine the communication effects (safety-related behavior) of selected capacity plate designs in an actual boating situation. The relevant safety-related behavior for this study translates as the boaters' likelihood of: 1) noticing a capacity plate design, 2) reading the capacity information for that design, and 3) comprehending the capacity information in the design.

The designs selected for evaluation in this phase of the project are as follows:

- Multiple enclosures and single enclosure with the capacity information presented in numerical/verbal order (e.g., "700 lbs People, Motor, and Gear");
- Numbers in the capacity recommendations in type face larger than the verbal information and numbers in the capacity recommendation in the same size type face as the verbal information; (impossible to test this variation of capacity plate design in Study 3 since the different size type faces could not be compared for valid results);
- Presentation of the horsepower capacity information within the same enclosure on the design as the weight capacity information, or presentation of the horsepower capacity below the enclosure. Study 2 suggested further evaluation of tnis design strategy. In that exploratory phase of the project, Design Q was valued among the highest rated designs on the attractiveness, simplicity, and authenticity dimensions. It was also among tne "most preferred" group of designs. Two strategies used in Design Q are noteworthy here. First, the horsepower recommendation was not included in the yellow enclosure in which the weight capacities were presented; and second, the order of the capacity recommendations was the verbal information followed by the capacity numbers. Study 3 demonstrated that the order of information used in Design Q was less effective for recognition than the alternative (capacity numbers followed by the verbal

information). The question remained as to the location of the horsepower recommendation on the capacity plate design. See foldout of designs for Study 4 in Appendix H. It should be noted that the single enclosure/smaller numbers designs were actually identical designs.

6.2 Operational Definition of Comprehension

Noticing, reading, and comprehending information were selected as criteria for this study since they are prior events necessary for the communication of capacity recommendations. As in Study 3, this evaluation required an operational definition of comprehension. However, the different tasks specified by the research design in the present study (persons were asked to do altogether different things - to behave in a different way) required an alternative operational definition. Comprehension in this study was determined by the retention and recall of specific capacity information presented in various capacity plate designs (rather than the recognition of capacity information as in Study 3). It was assumed that comprehension of the capacity information (or a basic level of understanding) was preliminary to accurate recall of that information, and should coincide with the amount of recall if other factors are held constant (such as amount of capacity information to be recalled). The recall variable was scored as a continuous attribute ranging from no recall to complete 100% recall.

6.3 Method

6.3.1 Review of General Procedure

The capacity plate designs were assigned randomly and mounted on a fleet of rental fishing boats. The boats were rented for various times over a two day period (a weekend) to boaters in the usual manner. When the rental boat was returned to the fishing camp, the operator of the boat was interviewed by a Wyle researcher. The interview provided the data for determining the communication effects of the capacity plate designs.

6.3.2 Materials for the Study

The materials requiring special preparation for use in the testing of the capacity plate designs included interview forms, and the test capacity plates to be mounted on the rental boats.

The interview forms consisted of two sections. Section one was a page for recording the boat operators' recall of the numbers on the capacity labels. The page was a Xerox copy of the exact capacity plate design mounted on the boat rented by the boater. The only difference between the actual design and the design printed on the interview form was the omission of all test numbers to be recalled. The intent of the form was to indicate to the boater being questioned the exact information necessary for recall, and at the same time offer cues to facilitate recall equally for all capacity plate designs. The boater was shown the page and asked to recall for the interviewer the capacity numbers that belonged in the blank spaces as best he could.

The second section of the interview form consisted of the schedule of all other interview items listed in order of questioning with spaces for recording the boaters' responses. Clipboards were used by the researchers during the interview in order to appear as if surveys were being made rather than the conduct of an experiment in which the boater had non-voluntarily participated by renting the boat.

The designs for the capacity plates were prepared in the same way as in the earlier stages of the project. That is, the designs were printed on white photosensitive card stock, the yellow enclosures were tinted with translucent adhesive film, and headliner type was used for the numbers and letters for the capacity information. The designs were then laminated in clear plastic. In all, six copies of each of the five designs were prepared for installation on the rental boats.

The capacity plates were mounted on the rental boats, using tape (in order to prevent damage to the boats). The tape was double-backed with adhesive, two inches wide, and cut in lengths slightly shorter than the length of the capacity plate it adhered. When the capacity plate was mounted on the boat, no trace of the tape was

visible. Inspection of the capacity plates at intervals during the experiment indicated that no apparent attempts to pry off the capacity plates were made by boaters during rental periods.

6.3.3 Assignment of Capacity Plate Designs to Rental Boats

Tucei's Fishing Camp, loacted on Mary Walker Bayou near Pascagoula, Mississippi, consented to cooperate with Wyle Laboratories for the project. In turn, Wyle donated one new boat to the fleet of rental boats. The fishing facility was selected for the study primarily because all of the 29 rental boats were identical (15-1/2 ft [4.7 m], semi-V plywood hull).* See Figure 6 for a photograph of one loaded rental boat. The capacity recommendations according to the manufacturer (Stauter Boat Works, Mobile, Alabama) were: 850 lb (385.6 kg) for persons, motor, and gear; 600 lb (272.2 kg) for persons, and a maximum of 25 hp for the outboard motor. Each boat was numbered serially 01 through 30 for rental purposes; boat number 29 was unavailable for renting.

The boats on which the capacity plate designs were to be mounted were designated using a random numbers procedure. The first six numbers taken from a random numbers table, ranging from 01 to 30 except 29, were to be assigned to the multiple enclosures design. The next eight numbers occurring in the random numbers table, not already given previously, were assigned to the single enclosure/smaller numbers design, and so on until all numbers 01 through 30 excluding 29 were assigned to a capacity plate design. The numbers were then translated to the serial numbers for the boats, and the capacity plate designs were mounted accordingly. The outcome of the random numbers procedure was as follows:

Multiple Enclosures:	Boats Numbered 12, 17, 21, 26, 27 and 28
Single Enclosure/ Smaller Numbers:	Boats Numbered 01, 03, 08, 09, 18, 22, 23, and 30

* Additional considerations in support of this rental agent were: 1) Tucei's Boat Rentals is the largest boat rental agent in the Gulf Coast area; 2) preliminary contact with Tucei's indicated that the boat rental season would continue through November (boat rental agents contacted farther north around the Huntsville area indicated that business had already slacked off considerably); 3) Tucei's showed enthusiastic support for the proposed project and promised all possible help to Wyle Laboratories and the United States Coast Guard.

Larger Numbers:	Boats Numbered 10, 15, 16, 20, and 25
Horsepower Inside Enclosure:	Boats Numbered 04, 05, 06, 19, and 24
Horsepower Outside Enclosure:	Boats Numbered 02, 07, 11, 13, and 14

The capacity plate designs were mounted on the port side of the transom. This position was selected because a boat operator normally faced this direction in the boat during loading of the fuel tank and for operation of the outboard motor. See Figure 7 for a photograph of the mounting position of the capacity plate designs.

6.3.4 Interview Procedure

Questioning of each boat operator was done as soon as the boat was unloaded after returning from fishing. One of two Wyle researchers on the site conducted each interview. As the operator of the boat completed unloading his boat, he was asked, "Can I ask you a few questions about the boat you just rented?" All but 2 persons approached consented to the interview. At that point the interviewer identified himself as an employee of Wyle Laboratories, and began the questioning.

The interview consisted of the following items:

- whether or not the boat operator noticed the capacity plate (if the operator did not notice the capacity plate, the interview was terminated)
- the operators' recollection of the numbers on the capacity plate
- at what time during the rental of the boat the operator first noticed the capacity plate
- whether or not the boat operator read the capacity recommendations at the time he first noticed the capacity plate
- the operators' impressions of the relative ease of reading and understanding the capacity recommendations
- the frequency with which the boat operator came to rent boats at the fishing camp (answer was in forced choice format: "often or regularly, a couple of times, for first time")

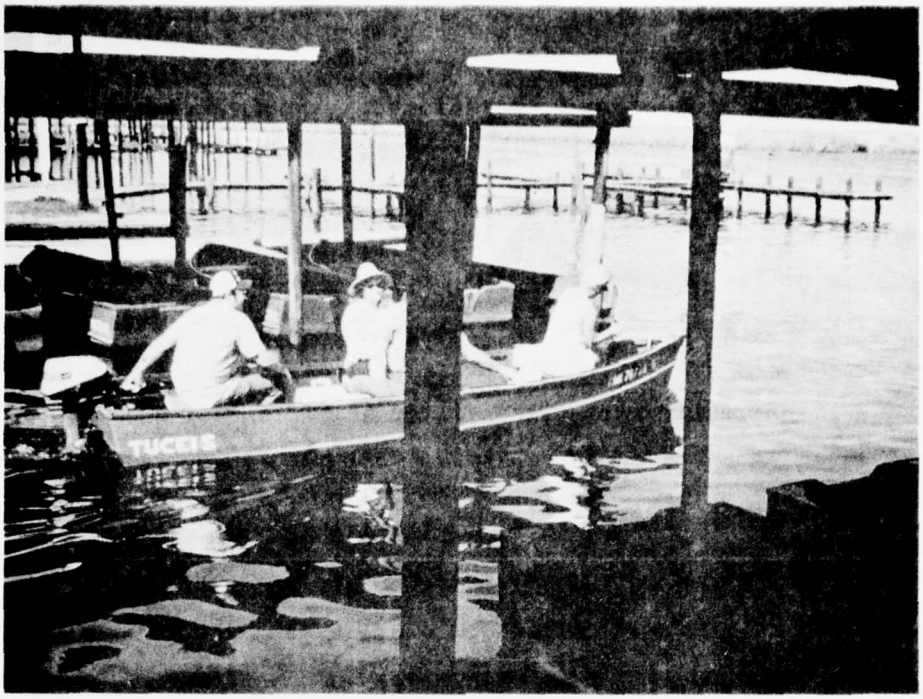


FIGURE 6. BOAT NO. 6 AND OCCUPANTS BEGINNING FISHING TRIP

FIGURE 7. MOUNTING POSITION FOR CAPACITY PLATE DESIGNS

- specific expectation the boat operator had concerning the capacities of the boat prior to this day's rental.

The latter two items were intended to assist in the interpretation of the boat operators' response on the criterion items. For example, if no differences were observed between the recall scores or other effects of the capacity plate designs, the actual cause of the outcome may have been the boaters' expectations of boat capacity from prior experience with the exact type of boat at the fishing camp. In addition, the items were used to profile the sample of boaters renting boats during the experiment. After the interviews, an explanatory letter in a sealed envelope was given to boaters who questioned the accuracy of the weights given on the capacity plates (see Appendix I).

6.4 Results and Findings

6.4.1 Measurement for the Study

The results of the study are based upon boaters' response to each of four interview items asked by the experimenters when each boater returned to the boat rental dock: 1) whether or not boaters noticed the capacity plate; 2) whether or not boaters read the capacity recommendations at the time of notice; 3) the time at which boaters first noticed the capacity plate during the rental of the boat (i.e., loading, going to fishing area, etc.); and 4) the extent to which boaters could recall each of the capacity numbers.

Scoring of boaters' recall was by treating each digit of the three capacity numbers (700 lb [317.5 kg], 450 lb [204.1 kg], and 25 horsepower) as a separate answer. For example, 700 lb (317.5 kg) was considered three possible answers, 450 lb (204.1 kg) was considered as three possible answers, and 25 horsepower was two more possible answers. A boater's score could range from zero correct to eight correct. This method of scoring facilitated measurement of near-correct guesses made by boaters when they could not remember all the numbers. A guess of 750 lb (340.2 kg) is a close guess to 700 lb (317.5 kg), and could therefore be counted as only one digit incorrect. The exception to this scoring procedure was made for the third capacity plate design having "3 Persons" in addition to "450 Pounds"

(scores could range from zero correct to nine correct). In order to compare overall scores for the various designs, percentages were calculated to compensate for the different number of possible "all correct" answers.

In order to provide an evaluation of individual characteristics of the design strategies, comparisons of the results were made between the pairs of designs having only one basic difference (as in Study 3 of the project). That is, the multiple enclosures design was compared to the single enclosure design*; the design having large numbers was compared to the design having small numbers; and the design having motor horsepower printed inside the yellow enclosure was compared to a design having motor horsepower printed outside of the yellow enclosure.

6.4.2 Noticing, Reading, and Speed of Noticing the Multiple and Single Enclosure Designs

The use of multiple enclosures for presentation of the capacity information produced somewhat inconsistent results. The multiple enclosures capacity plate design was noticed or seen by 62.5% of persons renting boats on which the design was mounted. The design was read at that time by 80% of those persons. The single enclosure (and smaller numbers) design was noticed by 90% of the persons and 78% read the capacity recommendations (see Appendix J for a summary table of the data). Data concerning the time at which persons first noticed the capacity plate was incomplete**. Of the data that was available for analysis, three of five persons first saw the multiple enclosure design at the time they loaded their boats; the other two persons saw the multiple enclosures design as they proceeded to the fishing area. For those persons in boats on which the single enclosure design was installed, three of seven persons first saw the capacity plate as they loaded their boats, and the remaining four persons saw the capacity plate as they proceeded to the fishing area (see Appendix K for a summary of reported times the designs were first noticed).

---

* The small number and single enclosure designs were actually identical designs. They are listed as separate designs for purposes of clarity in presenting the analysis and results.

** Data concerning the time the capacity plate designs were first noticed and the relative ease of reading were not collected for all subjects. When sufficient data was available for analysis, it was reported in this section. Collection of all possible data for all subjects was complicated by the unforeseen fact that boats often returned to the camp together. The interviewers chose to question all subjects on the most important criterion items rather than omit subjects and gather less important information (to minimize sampling error).

Computation of "exact probabilities"* to determine statistical significance of the difference between the number of persons who noticed the multiple enclosures design and those persons who noticed the single enclosure design indicated significance at the 0.2745 level of probability (see Table 12). It should be noted here that this test is intended to be used when the data is limited to a small number of observations. A brief discussion of the computational procedures for two tailed "exact probabilities" is presented in Appendix L.

TABLE 12. PERSONS NOTICING THE MULTIPLE AND SINGLE ENCLOSURE DESIGNS

Designs	Number of Persons Not Seeing Capacity Plate	Number of Persons Seeing the Capacity Plate
Multiple Enclosures	3	5
Single Enclosure	1	9

(p = 0.2745)

Computation of "exact probabilities" to determine statistical significance of the difference between the number of persons who read the multiple enclosures capacity plate at the time they first noticed it, and those who read the single enclosure capacity plate when they first noticed it indicated no statistical significance (see Table 13).

TABLE 13. PERSONS READING THE MULTIPLE AND SINGLE ENCLOSURE DESIGNS

Designs	Number of Persons Not Reading Capacity Plate	Number of Persons Reading Capacity Plate
Multiple Enclosures	1	4
Single Enclosure	2	7

(p = 1.00)

* Exact probabilities were calculated using the Fisher technique for 2 x 2 (four cell) tables having low frequencies. For a discussion of the test, see Siegel, Sidney, Non-Parametric Statistics for the Behavioral Sciences, New York: McGraw-Hill Book Company, Inc., 1956, pp 96-104; Ferguson, George, Statistical Analysis in Psychology and Education, New York: McGraw-Hill Book Company, Inc., 1966, pp 208-210; and Bradley, James V., Distribution-Free Statistical Tests, Englewood Cliffs, Prentice-Hall, Inc., 1968, pp 195-203.

To summarize, the multiple enclosures capacity plate design tended to attract fewer persons for simply noticing the capacity plate than did the single enclosure design, but the multiple enclosures design tended to have been noticed earlier. There is no apparent difference in the tendency for either design to be read at the time it was noticed as indicated by the statistical test.

6.4.3 Noticing, Reading, and Speed of Noticing Larger Numbers and Smaller Numbers Designs

All operators on whose boats the larger numbers capacity plates were mounted noticed the capacity plate and read the capacity information at that time. Again, 90% of the persons (nine of ten persons) noticed the smaller numbers (and single enclosure) capacity plate, and 78% of that group read the recommendations. Regarding the time at which the capacity plate was first noticed after the boat was rented, two persons (of five for whom data was given) first noticed the larger numbers design as they loaded their boats; two more persons noticed the capacity plate as they proceeded to the fishing area; and one person noticed the capacity plate after he began fishing. Again, the smaller numbers design was seen by all persons prior to arriving at the fishing area.

Computation of "exact probabilities" to determine statistical significance of the difference between the number of persons noticing the larger numbers design and the number of persons noticing the smaller numbers design indicated no significant difference (see Table 14).

TABLE 14. PERSONS NOTICING THE LARGER AND SMALLER NUMBERS DESIGNS

Design	Number of Persons not seeing Capacity Plate	Number of Persons seeing Capacity Plate
Larger Numbers	0	5
Smaller Numbers	1	9

($p = 1.00$)

Computation of "exact probabilities" to determine statistical significance of the difference between the number of persons reading the larger numbers capacity plate and the smaller numbers capacity plate indicated a low probability of significance (see Table 15).

TABLE 15. PERSONS READING THE LARGER AND SMALLER NUMBERS DESIGNS

Design	Number of Persons Not Reading Capacity Plate	Number of Persons Reading Capacity Plate
Larger Numbers	0	5
Smaller Numbers	2	7

($p = .5055$)

To summarize, there does not appear to be much difference between the two designs on the noticeability measures; however, the fact that all operators read the larger numbers capacity plate designs appears noteworthy.

6.4.4 Noticing, Reading, and Speed of Noticing Horsepower Inside Enclosure and Horsepower Outside Enclosure Designs

The design having motor horsepower printed inside of the yellow area was seen or noticed by 60% of the persons (three persons out of five). Two of the three read the recommendations at that time; one person noticed the capacity plate while loading his boat; the other person (for whom data was available) noticed the capacity plate on the way to the fishing site. The alternative design (motor horsepower recommendation printed outside the yellow area) was noticed by three persons (only three persons were interviewed in this condition). One person read the capacity information; one noticed the capacity plate while loading his boat; and the other (for whom data is given) noticed the capacity plate while fishing.

There were too few interviews to enable any further comparisons, or to conduct tests of statistical significance for the horsepower alternative design. It is the opinion of the researcher that in general, the two designs concerning the enclosure of motor horsepower were not as effective as the other three designs. In fact, the

attempt to modify the designs for the evaluation took away much of the attractiveness of the design as it was originally conceived (Design Q in Study 2). Consequently, additional analysis of these data may not be warranted even if more persons were available.

6.4.5 Accuracy of Recall of Capacity Numbers

The third measure for evaluating effectiveness of the capacity plate designs was the boat operators' recall of the numbers given for the capacity information. Overall, the five designs produced different recall scores when all designs were compared. Statistical significance for the difference of recall was tested using the "goodness of fit" technique* and the Chi Square statistic. The "goodness of fit" technique was intended to determine if the actual distribution of recall scores differed significantly from those scores that would be expected by chance. Chance score values for each design would be proportional to the number of possible correct answers. If the observed correct score for each design was not sufficiently different from the chance (expected) value for the design, then the design did not produce any systematic difference in recall. The observed correct recall scores, the percentage of correct recall scores, and the possible correct answers are presented in Table 16. Computations for determining the expected values for the "goodness of fit" technique and for the Chi Square statistic are presented in Appendix M.

---

* The "goodness of fit" technique is discussed in Ferguson, George A., Statistical Analysis in Psychology and Education, New York: McGraw-Hill Book Co., 1966, pp 195-200.

TABLE 16. RECALL SCORES FOR CAPACITY NUMBERS FOR ALL CAPACITY PLATE DESIGNS

Capacity Plate Design	Recall Score	Total Correct Possible*	Percentage Correct
Multiple Enclosures	28	64	43.75
Single Enclosure/Smaller Numbers	46	80	57.50
Larger Numbers	26	40	65.00
Horsepower Within Enclosure	15	45	33.33
Horsepower Outside Enclosure	7	36	19.44
Total Recalled Numbers	122	--	-----
Total Possible Numbers	---	265	-----

(Chi Square: $\chi^2 = 12.607$, $df = 4$, $p < 0.05$)

The capacity plate design producing the best retention was the larger numbers design with 65% of the total digit numbers recalled. The single enclosure/smaller numbers design produced the next best retention with 57.5% of the total digit numbers recalled. The multiple enclosures design produced 43.75% recall and ranked third best overall. It should be noted that the best three capacity plate designs for recall employed identical verbal phrasing for the capacity recommendations.

Computation of Chi Square to determine if the difference between the number of digits recalled for the various designs and their alternatives indicated the following comparisons and results (see Table 17).

* The total correct possible was calculated by multiplying the total number of digits for the capacity plate design times the number of persons interviewed for that design condition; hence, the total correct possible of 64 results from the eight digits on the multiple enclosures design times the eight persons interviewed in that condition.

TABLE 17. COMPARED CAPACITY PLATE DESIGNS FOR RECALL OF CAPACITY INFORMATION

Comparison	Recall Score In Percentages	Computed Chi Square	Probability
Multiple Enclosures To Single Enclosure	43.8 57.5	2.691	$p > 0.05$
Larger Numbers To Smaller Numbers	65.0 57.5	0.625	$p > 0.05$
Horsepower Inside To Horsepower Outside	33.3 19.4	1.950	$p > 0.05$

Apparently, the extent of the differences in recall for individual comparisons between the designs and their alternatives were insufficient to be statistically significant. However, the general comparison of recall for the different designs in the previous analysis was statistically significant. This inconsistent outcome is the probable result of limitations of the statistical procedures themselves.

6.4.6 Determination of Best Overall Designs

The larger numbers design and the single enclosure/smaller numbers design appeared to be the better overall designs (as observed in analysis in the previous section). Two comparisons were made to determine if the differences between these designs and those less effective designs were statistically significant. The actual selection of the better designs was based upon: 1) the common design characteristics shared by the capacity plates producing the highest frequency of persons seeing and reading the capacity information, and 2) the designs producing the best recall scores. The intent of the comparisons was to isolate design characteristics likely to produce the best readership and retention of information on capacity plates used on boats in the future.

Examination of the common characteristics shared by the capacity plate designs indicated two aspects of presentation of the information different from the other designs:

1) use of single enclosure for all recommendations as opposed to separating the information as in the multiple enclosures, or printing motor horsepower outside of the yellow enclosure

2) use of parallel structure for presentation of the capacity weight recommendation (total weight recommendation and occupant weight recommendation) as opposed to alternating weight capacity and number of occupants recommended for the boat capacity (total weight, occupant number, and occupant weight).

"Exact probabilities" were calculated to determine statistical significance of the difference between the combined frequencies of persons seeing and reading the two best designs, and the combined frequencies of persons seeing and reading the multiple enclosures and the two horsepower alternative designs. The difference was significant within the 10% level of probability.* The combined frequencies and the outcome of the "exact probabilities" test are presented in Table 18.

TABLE 18. PERSONS NOTICING CAPACITY PLATE DESIGNS IN COMBINED COMPARISONS

Designs	Number of Persons Not Seeing or Reading Capacity Plate	Number of Persons Seeing and Reading Capacity Plate
Larger Numbers and Single Enclosure/Smaller Numbers Designs	3	12
Multiple Enclosures, Horsepower Inside, and Horsepower Outside Designs	9	7

($p = 0.0659$)

* It is extremely likely that this is a "significant event" given that differences between recall scores for the combined capacity plate designs (next analysis) were statistically significant within the 5% level.

The Chi Square statistic was used to determine if the difference between recalled capacity information was statistically significant for the same two combined groups of capacity plate designs. The difference between the two best designs and the three less effective designs for recall was significant at the 5% level of probability. The combined recalled numbers and the outcome of the Chi Square test are presented in Table 19.

TABLE 19. RECALL SCORES OF CAPACITY NUMBERS IN COMBINED COMPARISON

Designs	Number of Incorrectly Recalled Numbers	Number of Correctly Recalled Numbers
Larger Numbers and Single Enclosure/Smaller Numbers Designs	28	92
Multiple Enclosures, Horsepower Inside, and Horsepower Outside Designs	83	62

($\chi^2 = 31.01$, $df = 1$, $p < 0.05$)

6.4.7 Corollary Findings Concerning Noticeability of Capacity Plates

Two observations concerning the general tendency of boat operators to notice or see the capacity plates warrant additional analysis and reporting. First, there was a tendency for the capacity plate to be noticed during the earlier stages of renting the small boats and during the preparation for the fishing trip. The number of persons who noticed the capacity plate in the first half of the rental time for the boat was tallied and compared to the number of persons who noticed the capacity plate in the latter parts of the fishing excursion. Ten of the 21 persons (for whom data was available) first noticed the capacity plate during loading of the boat. Nine others first noticed the capacity plate as they proceeded to the fishing area or were beginning fishing. Only two persons noticed the capacity plate as they proceeded back to the boat dock. The difference between the persons who reported noticing the capacity plate in the first half of the boat rental time and the persons noticing the capacity plate in the second half was statistically significant ($\chi^2 = 13.72$, $df = 1$, $p < 0.05$).

The second observation concerned the tendency of the capacity plate to be more likely noticed by persons frequenting the boat rental facility. The probable novelty of having a capacity plate mounted on a boat they knew well accounts for the effect. See Appendix N for the frequencies of persons first noticing the capacity plate and the classification concerning now often they came to the fishing camp. No analysis appeared warranted for the expectations the operator had of specified boat capacities. Comments given during the interviews indicate that persons tended to rely on the rental agent's recommendations for capacities rather than to hold specific expectations based on boat size, etc.

6.5 Recommendations

Two similar capacity plate designs evolved as the better overall designs: the larger numbers capacity plate design and the single enclosure/smaller numbers design. Since persons were more likely to read the larger numbers design when they saw it in this study, it is predicted that the design would invite more reading when installed on otner boats.

One final note to the capacity plate design evaluations. The logical next step would seem to be the development of base materials, ink, and an installation procedure that would be durable, attractive, and likely to be maintained by the boat owners to retain the new, readable appearance of the capacity plate.

REFERENCES

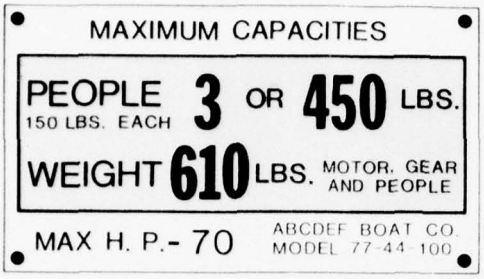
1. USCG Research and Development Center. "Safe Loading Operator Task Cause Identification Report." 1975.

2. MacNeill, Robert F. "Capacity Plate Effectiveness: Pleasure Boats." Published by Wyle Laboratories for U. S. Coast Guard. July 1975. NTIS No. AD-A014-094.

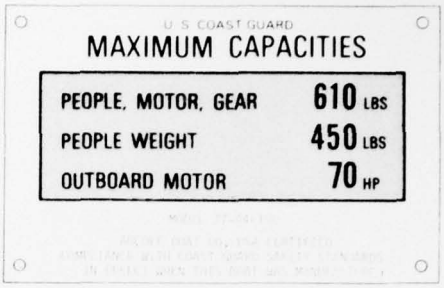
3. Lancaster, Gayle and C. Christian Stiehl. Safe Loading Operator Study. Published by Wyle Laboratories for U. S. Coast Guard. June 1976.

APPENDIX A — FOLDOUT OF NINE NEW CAPACITY PLATE DESIGNS (STUDY 2)

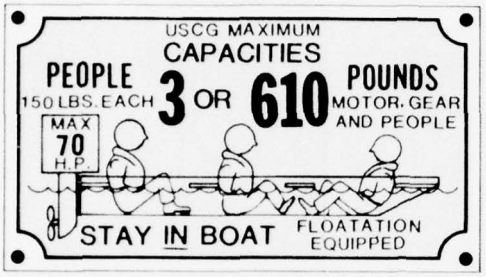
DESIGN Q



DESIGN V

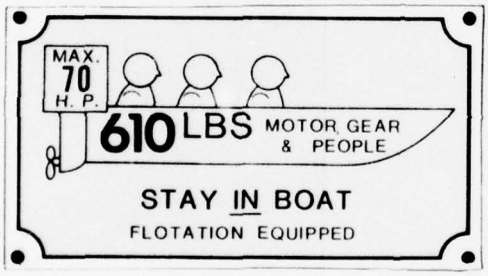


DESIGN R

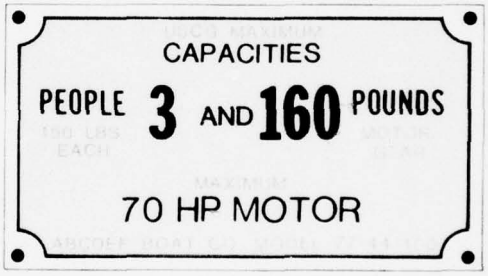


DESIGN W

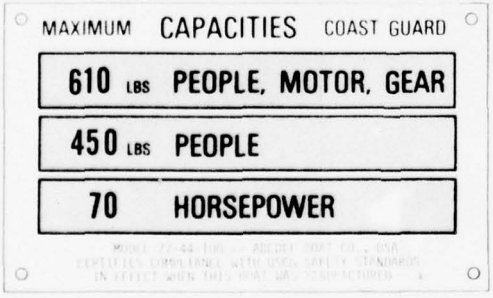
DESIGN S



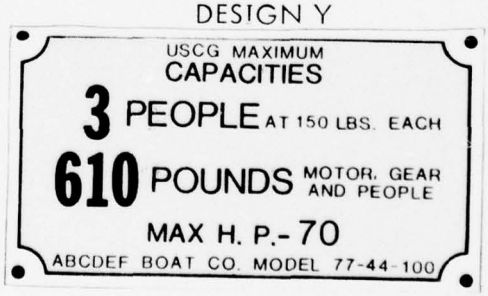
DESIGN X



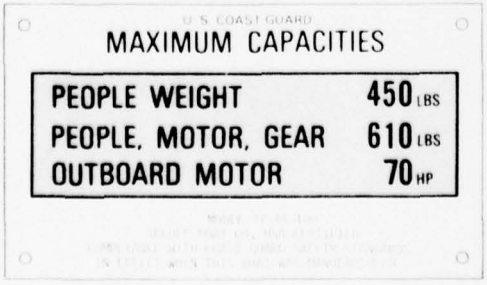
DESIGN T

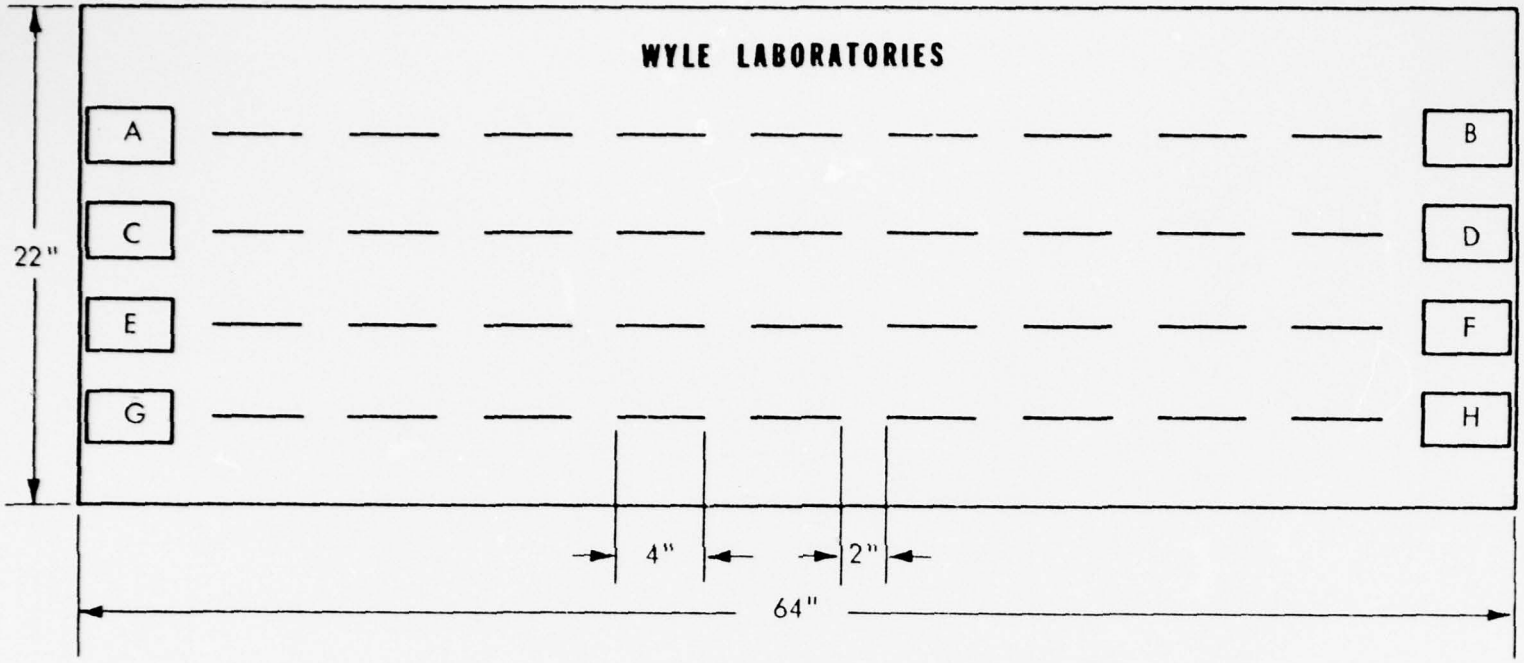


DESIGN Y



DESIGN U





Key for opposing word/phrases for scale polarity:

A = Least enjoyable
B = Most enjoyable
C = Least attractive
D = Most attractive
E = Least simple and etficient
F = Most simple and efficient
G = Least authentic and believable
H = Most authentic and believable

APPENDIX C —
INSTRUCTIONS READ TO RESPONDENTS (STUDY 2)

RECRUITING OF RESPONDENTS:

We are running a study to determine various ways capacity plate information can be presented. The results of the study will be used in the design of capacity plates for boats built in the future. Will you give us 10 or 15 minutes and help us by judging several sample capacity plates?

ADMINISTRATION OF STUDY:

VOLUNTEER RESPONDENT (R) IS TAKEN TO WYLE VAN FOR TESTING BY TWO EXPERIMENTERS (E). WHEN E IS READY TO BEGIN, E SAYS:

You are being asked to help determine different ways certain capacity information can be presented on boats. The task is in two parts. First, we'll ask you to judge several capacity plates containing the same information; the way the information is presented is different. Then, I'll ask you a brief series of questions about how you feel about certain capacity plate designs.

E ARRANGES ALL NINE CAPACITY PLATE CARDS IN THE CENTER POSITIONS OF THE SCALES ON THE BOARD (NO DESCRIPTIVE WORD/PHRASE ON THE ENDS OF THE SCALES IS VISIBLE). E CONTINUES:

Here are the capacity plates you'll be judging. Again, they each contain the same information. I'll point out the basic differences for the way the information is presented. Here the information is presented in boxes. Here the information is partly pictured, and here the same weight capacities are presented either broken down or combined. For instance, the number of persons is given separately from the total weight allowed in the boat (three persons each weighing 150 pounds).

AFTER R HAS FAMILIARIZED HIMSELF WITH THE CAPACITY PLATES, E COLLECTS THE PLATES. E CONTINUES:

Here is how to judge the capacity plates. I will hand you the plates. You look at them as long as you wish. Then, you place the plates on the spaces on the board. For example, take the top line of spaces. Each end of the line has descriptive word/phrases ("Most Enjoyable" and "Least Enjoyable"). If you felt that the plate was enjoyable, use this end of the line. If you felt the plate was not very enjoyable, use this end of the line. Just place the plate down on the space to indicate your judgement. We will do one line at a time. As you are making your judgments, remember three things:

1) When you finish with each line, you will really have ranked the capacity plates from "the most" to "the least" on each line or scale.

2) The spaces between the capacity plates should correspond to differences you feel about the capacity plates.

3) You don't need to fill all of the spaces with the capacity plates. You can place some of them one on top of the other if you feel there is no difference between them, and you don't need to use the extreme spaces on the ends unless you actually feel capacity plates belong there.

OK... any questions?

E COVERS THE WORDS ON THE FIRST LINE USED FOR EXAMPLE PURPOSES, UNCOVERS THE WORDS AT EACH END OF THE SECOND LINE ("MOST ATTRACTIVE" AND "LEAST ATTRACTIVE"), HANDS THE TEST SET OF CAPACITY PLATE CARDS TO R, AND SAYS:

All right. Go ahead and make your judgments of the nine capacity plates according to how attractive each plate is for you personally.

WHEN R COMPLETES THE FIRST SERIES OF JUDGMENTS, E RECORDS THE POSITION OF EACH CAPACITY PLATE USING THE LETTERS ON THE BACKS OF THE CARDS AND THE TALLY SHEET FOR THAT PARTICULAR RESPONDENT. E COVERS THE WORDS FOR THE SECOND LINE, REORDERS THE CAPACITY PLATES ACCORDING TO A RANDOM NUMBER SEQUENCE, RETURNS THEM TO R, UNCOVERS THE WORDS ON THE THIRD LINE ("MOST SIMPLE AND EFFICIENT" AND "LEAST SIMPLE AND EFFICIENT"), AND SAYS:

All right. Go ahead and make your judgments of the capacity plate according to how simple and efficient each plate is for you personally. The most simple and efficient plate would be the one that is easiest to understand.

WHEN R COMPLETES THE SECOND SERIES OF JUDGMENTS, E RECORDS THE POSITION OF EACH CAPACITY PLATE, COVERS THE WORDS FOR THE THIRD LINE, REORDERS THE CAPACITY PLATES, RETURNS THEM TO R, UNCOVERS THE WORDS ON THE FOURTH LINE ("MOST AUTHENTIC AND BELIEVEABLE" AND "LEAST AUTHENTIC AND BELIEVEABLE"), AND SAYS:

All right. Go ahead and make your judgments of the capacity plates according to how authentic and believable each plate is for you. The most authentic and believable plate is the one that looks like it conveys the most accurate information about boat capacity.

WHEN R COMPLETES THE THIRD SERIES OF JUDGMENTS, E RECORDS THE POSITION OF EACH CAPACITY PLATE, COVERS THE WORDS FOR THE FOURTH LINE, COLLECTS THE LABELS, AND SAYS:

Now we are ready for the second part of the study. I'll ask you some brief questions concerning how you ranked the capacity plates. Ready?

1) Recall that you felt this plate (PLATE RANKED MOST ATTRACTIVE BY R) was the most attractive. Why? (E RECORDS ANSWERS ON TALLY SHEET.

2) Recall that you felt this plate (PLATE RANKED LEAST ATTRACTIVE BY R) was the least attractive. Why?

3) Recall that you felt this plate (PLATE RANKED MOST SIMPLE, ETC. BY R) was the most simple and efficient. Why?

4) Recall that you felt this plate (PLATE RANKED LEAST SIMPLE, ETC. BY R) was the least simple and efficient. Why?

5) Recall that you felt this plate (PLATE RANKED MOST AUTHENTIC, ETC. BY R) was the most authentic and believable. Why?

6) Recall that you felt this plate (PLATE RANKED LEAST AUTHENTIC, ETC. BY R) was the least authentic and believable. Why?

E CONTINUES:

Now that you are very familiar with each presentation of boat capacity type of information, I'm going to ask you one more question about them. Consider the following situation. I am going to have one of these made up for your own use... for you to place on your boat where you or other persons using your boat can readily refer to it. Please pick the particular capacity plate you would like made up for you. This is a hypothetical situation.

E RECORDS R's SELECTION AND SAYS:

Please tell me your age... please tell me if you have less than or more than 100 hours of boat operating experience... under 20 hours (or over 500 hours)... and the primary way you use your boat such as cruising, water skiing, etc.

E RECORDS R's SEX AND ANSWERS TO THE CLASSIFICATION ITEMS. THEN E SAYS:

Thank you very much for your help. We really appreciate the time and thought you have given for this study. I can assure you that your opinions will be valuable in the development of capacity plate designs. Your part in this project is completed.

RESPONDENT NO. _____

DATE: _____

LOCATION: _____

_____

I. Ratings (enter letters on back of labels)

Least Attractive _____ _____ _____ _____ _____ _____ _____ _____ _____ Most Attractive

Least Simple _____ _____ _____ _____ _____ _____ _____ _____ _____ Most Simple

Least Authentic _____ _____ _____ _____ _____ _____ _____ _____ _____ Most Authentic

II. Why most attractive _____

_____

Why least attractive _____

_____

Why most simple _____

_____

Why least simple _____

_____

Why most authentic _____

_____

Why least authentic _____

_____

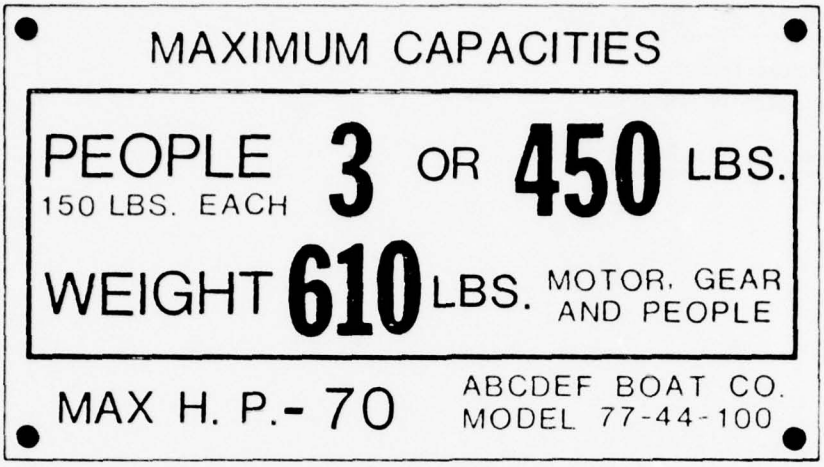
III. Selected Capacity Plate _____

IV. Sex _____ Age _____ Hours of Boating Experience: Under 20 ____; 20-100 ____; 100-500 ____; over 500 ____

Primary use of Boat: Cruising ____; Water skiing ____; Fishing ____; Other _____

APPENDIX D — FORM FOR RECORDING RESPONDENTS' RATINGS OF CAPACITY PLATE DESIGNS

APPENDIX E — COMMENTS ON EXTREME HIGH AND LOW RATINGS FOR CAPACITY PLATE DESIGNS

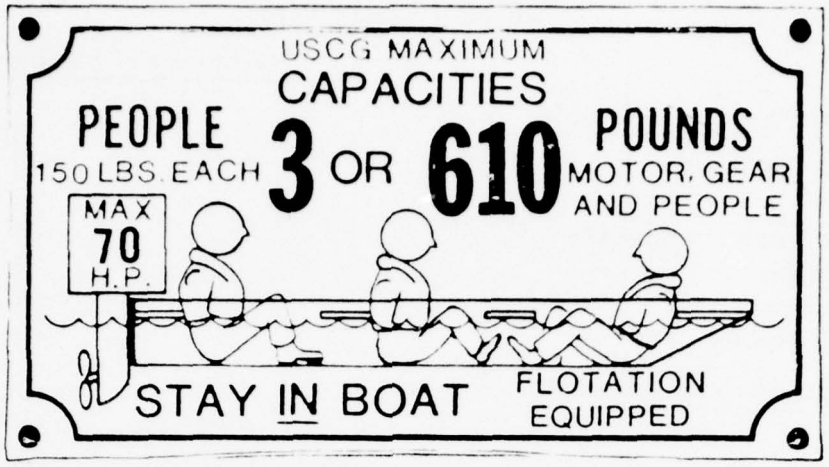


DESIGN Q

	Frequency of Mention by Respondents
Rated Most Attractive	
Self-explanatory	1
Simple	3
Easy to read	1
Clear lines	1
People weight broken down	1
Spread out	1
Not busy	1
Precise	1
All relevant information is there	1
Rated Least Attractive	
More difficult to understand	1
Gaudy and big	1
Jumps out at you	1
Rated Most Simple and Efficient	
Size of print and numbers	2
Points out information easiest	1
Boldness	1
Stands out	1
Rated Least Simple and Efficient	

DESIGN Q (concluded)

	Frequency of Mention by Respondents
Rated Most Authentic and Believable	
Easy to figure it out	1
States "maximum capacity"	2
Rated Least Authentic and Believable	

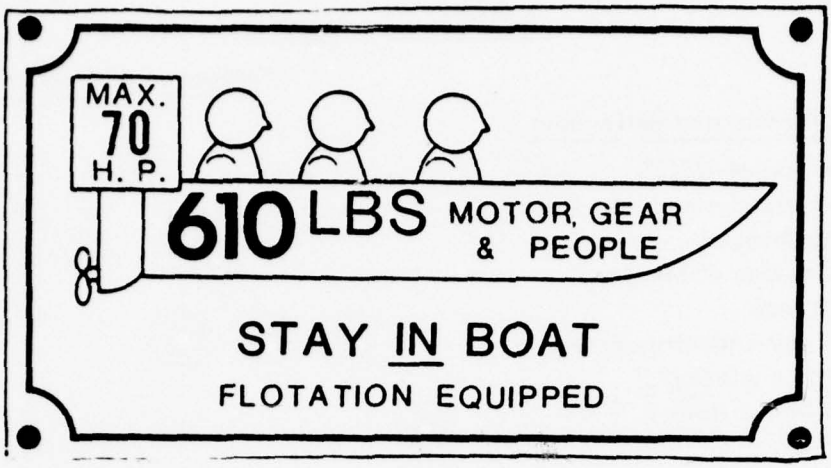


DESIGN R

	Frequency of Mention by Respondents
Rated Most Attractive	
Eye appealing/catching	2
Boat design pictorializes information	1
Rated Least Attractive	
Too busy	2
Negative with boat sinking	1
Cluttered	2
Boat sinking adds nothing	1
Difficult to understand	1
Cartoon	1
Confusing (no contrast)	1
Rated Most Simple and Efficient	
Use of picture	1
Rated Least Simple and Efficient	
Too busy	2
Too much on plate	1
More difficult to figure up capacities	1
Cluttered	1
Small print	1
Must search for information	1

DESIGN R (concluded)

	Frequency of Mention by Respondents
Rated Most Authentic and Believable	
Self-explanatory	1
Simple	1
Can visualize three people	1
USCG approval	2
Use of picture	1
Large letters for print	1
Rated Least Authentic and Believable	
Negative	1
Cartoon	2
One-hundred and fifty pounds may not apply in all cases	1
Stay in boat not credible	1
Too much confusion	1
Like telling a story	1

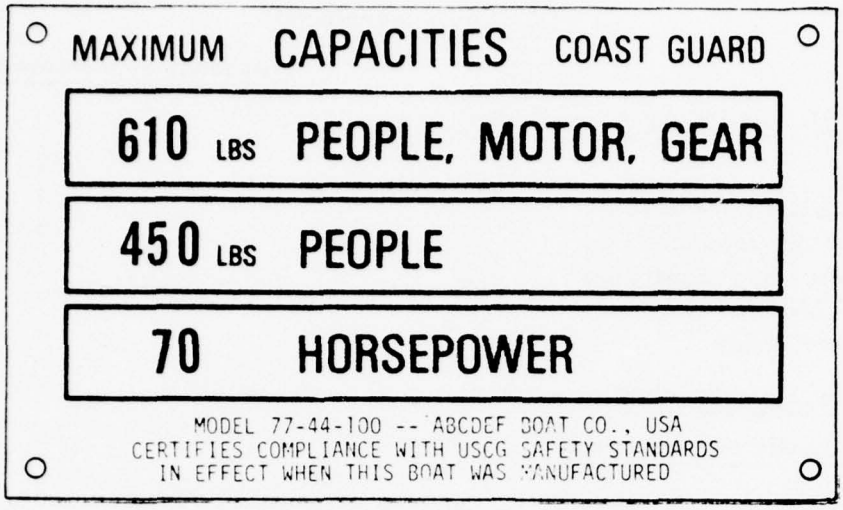


DESIGN S

	Frequency of Mention by Respondents
Rated Most Attractive	
Shape of boat	1
Total weight stands out	1
Flotation equipped	1
Grabs attention	1
Rated Least Attractive	
Difficult to get information	1
Does not give all information	1
Rated Most Simple and Efficient	
Self-explanatory	1
Least cluttered	1
Shape of boat	1
Rated Least Simple and Efficient	
Stay in the boat	1
Lacks authenticity	1
Too simple	1
Does not say anything or enough	1
Rated Most Authentic and Believable	
Self-explanatory	1
More information on this one	1
Pictorial	1

DESIGN S (concluded)

Rated Least Authentic and Believable	Frequency of Mention by Respondents
No mention of USCG	6
Possible mistake on weight analysis	1
Nothing stressed	1
No indication of company	1
Cartoon look	2
Doesn't say capacity anywhere	1
Too much confusion	1
Like telling a story	1

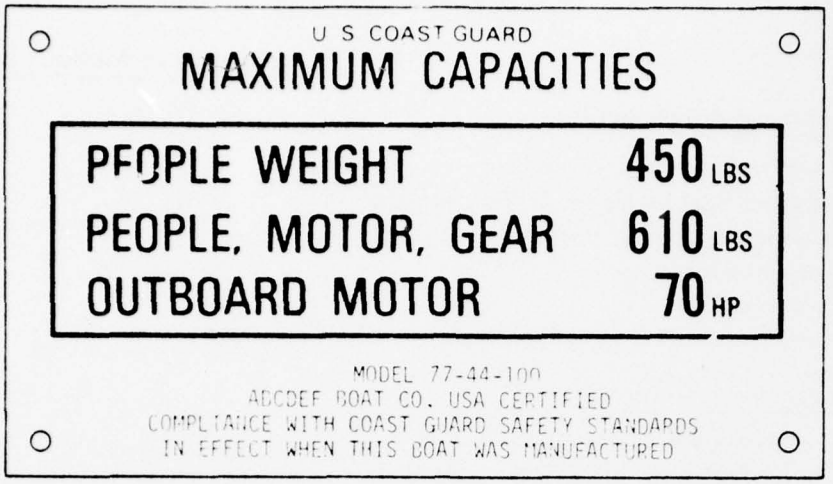


DESIGN T

	Frequency of Mention by Respondents
Rated Most Attractive	
Spacing	1
Boldness of print	1
Straight forward	1
Simple	1
Easy to read	1
Easy to get information	1
Stresses separate information	1
Individualizes	1
Things are proportional and equal	1
Rated Least Attractive	
Rated Most Simple and Efficient	
Order of print	1
Boldness	1
Rows used for information	1
Separation	1
Read left to right	1
Maximum weight first	1
Breaks down in terms of people	1
Attracted attention first	1
Broken down nicely	1
Easy to read	3

DESIGN T (concluded)

	Frequency of Mention by Respondents
Rated Most Simple and Efficient (concluded)	
Striking	1
Quick to get information	1
Contrast and separation	1
Easy to see from a distance	1
To the point	1
Non-boat design	1
Rated Least Simple and Efficient	
Rated Most Authentic and Believable	
Boldness	1
Order of information	1
Straight forward	1
Total weight on top	1
Easy to see	1
States maximum capacity	2
Good break down	1
Small print on the bottom	2
Like the capacity plates are now	1
Serious	1
Rated Least Authentic and Believable	
Hard to divide the people	1

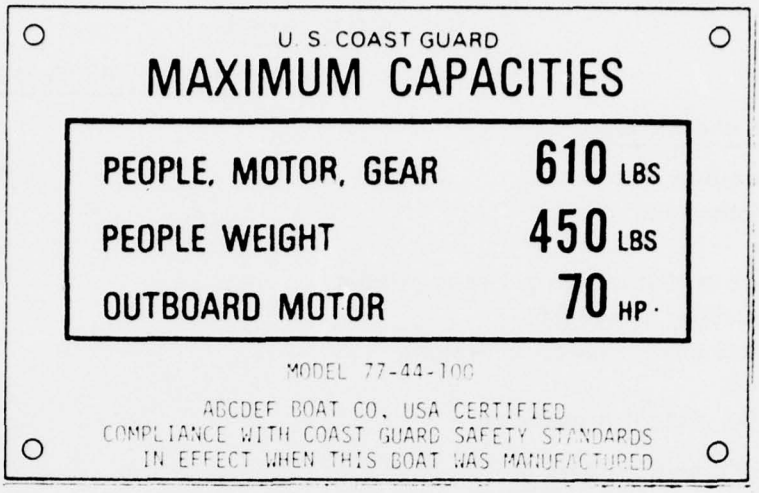


DESIGN U

	Frequency of Mention by Respondents
Rated Most Attractive	
Easy to read	1
Neater	1
Simple	1
All relevant information is there	1
Precise	1
Eye appealing - box is more attractive	1
Rated Least Attractive	
Common tag	1
Plain writing is not attractive	1
Rated Most Simple and Efficient	
Order of print	1
Boldness	1
No need for pictures	1
Arranged like a table or chart	1
Everything is right there	1
To the point	1
Non-boat design	1
Rated Least Simple and Efficient	
Needs separation of weights	1
Easy to confuse horsepower as weight	1
Reading is required	1

DESIGN U (concluded)

	Frequency of Mention by Respondents
Rated Most Authentic and Believable	
USCG is written where it is obvious	2
Smaller print at bottom makes it look official	1
Maximum weights without person breakdown	1
Factual presentation	1
Data only presented	1
Official size	1
Block form	1
Whole shapes	1
Similar to plates now	1
Rated Least Authentic and Believable	
Information is bunched up	1
Missed USCG approval	1

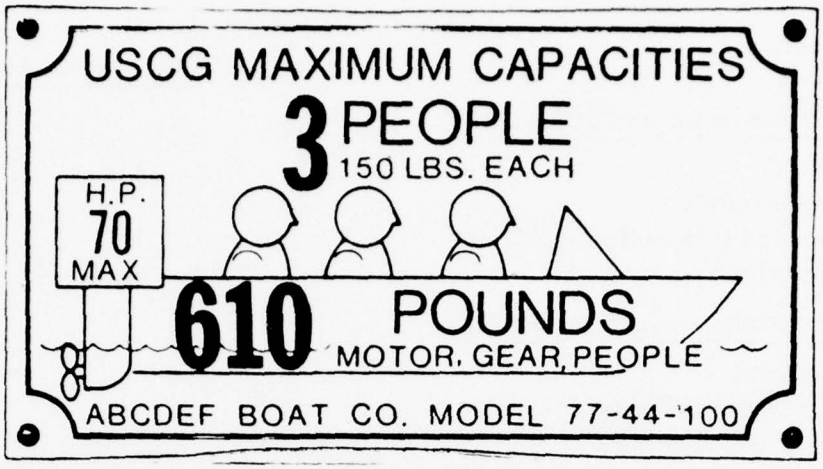


DESIGN V

	Frequency of Mention by Respondents
Rated Most Attractive	
Easy to read	1
Maximum weight first	1
Not cluttered	1
Less confusing	1
Rated Least Attractive	
Another technical piece of information	1
Like legal print	1
Hard to pick out information	1
Small print - hard to read	2
Wasted space	1
Rated Most Simple and Efficient	
Easy to read	1
Quick to get information	1
No need for pictures	1
Arranged like a table or chart	1
Everything on it	1
To the point	1
Non-boat design	1

DESIGN V (concluded)

	Frequency of Mention by Respondents
Rated Least Simple and Efficient	
Required reading	1
Would not stand out	1
Small type	2
No emphasis or distinction between numbers	1
Needs separation of weights	1
Easy to mistake horsepower for weight	1
Hard to read	1
Does not like weight breakdown	1
Rated Most Authentic and Believable	
Looks official, binding and legal	1
Smaller print at bottom makes it look official	1
Maximum weights without person breakdown	1
Factual presentation	1
USCG	1
Data only presented	1
Official size	1
Block form	1
Whole shapes	1
Like the plates now	1
Serious	1
Rated Least Authentic and Believable	
Information is crowded together	1
Missed USCG approval	1
Small, hard to read	1

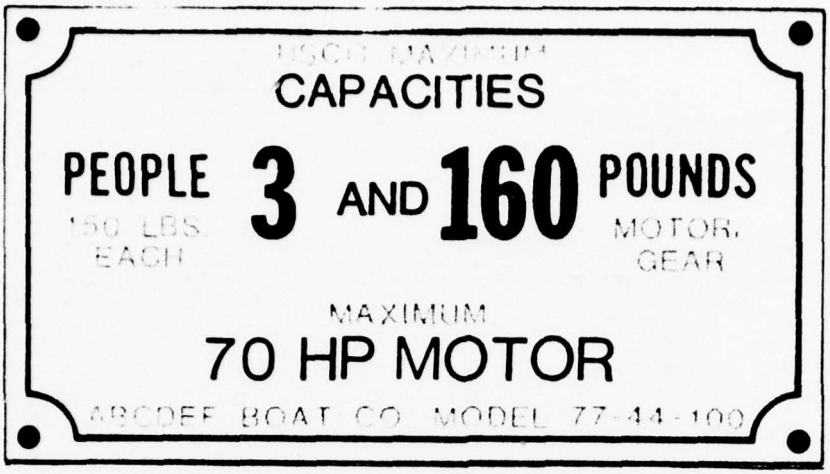


DESIGN W

	Frequency of Mention by Respondents
Rated Most Attractive	
Balanced, clear presentation	1
Straight forward	1
Optimum detailing (610 lbs is printed "in the boat")	1
Grabs attention	1
Boat design	1
Pictorial of what is said	2
Rated Least Attractive	
Confusing	1
Lack of contrast	1
Rated Most Simple and Efficient	
Use of picture	2
Likes sequence - 3 people vs. people 3	1
Large numbers	1
Shows information needed	1
Easily read	2
Liked breakdown	1
Rated Least Simple and Efficient	
Scattered information	1
Cluttered	1
Too busy	1
Too much searching involved	1

DESIGN W (concluded)

	Frequency of Mention by Respondents
Rated Most Authentic and Believable	
USCG	3
Large letters	1
Needed information supplied	1
Pictorial	1
Rated Least Authentic and Believable	
Cartoons	2
Too much confusion	1
Like telling a story	1

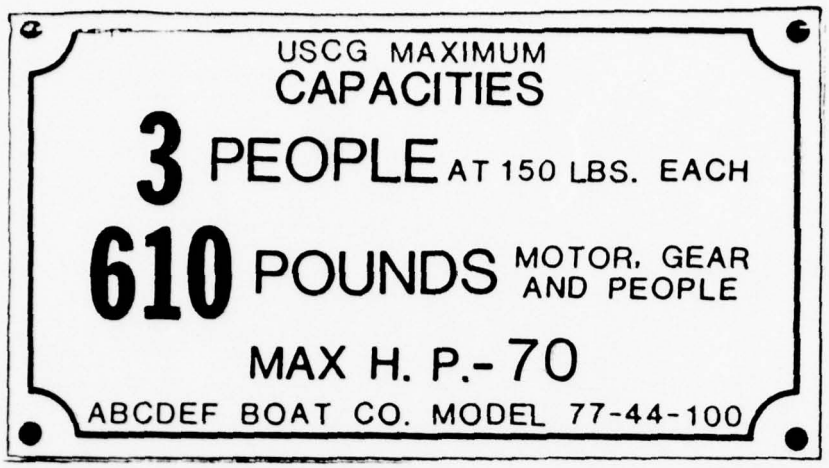


DESIGN X

	Frequency of Mention by Respondents
Rated Most Attractive	
Rated Least Attractive	
More difficult to understand	1
Too simple	1
Looks cheap	1
Light print	1
Difficult to read	1
Lacks information	1
One-hundred and sixty pounds means nothing	1
Rated Most Simple and Efficient	
Likes how broken down	1
Rated Least Simple and Efficient	
Required computation of values for analysis	1
Lacks data	1
Does not present data required	1
Rated Most Authentic and Believable	
"Maximum capacity"	1
USCG	1

DESIGN X (concluded)

Rated Least Authentic and Believable	Frequency of Mention by Respondents
Can't read designation too well	1
Use of "and"	1
People 3 order is undesirable	1
Number and words are reversed	1



DESIGN Y

	Frequency of Mention by Respondents
Rated Most Attractive	
Neater	1
Full on plate	1
Rated Least Attractive	
Difficult to get information	1
Takes time to digest	1
Requires too much figuring	1
Can't pick up the value	1
Rated Most Simple and Efficient	
Rated Least Simple and Efficient	
Rated Most Authentic and Believable	
"Maximum capacity"	1
USCG	1
Rated Least Authentic and Believable	

APPENDIX F — FOLDOUT OF DESIGNS FOR STUDY 3

MULTIPLE ENCLOSURE

MAXIMUM CAPACITIES COAST GUARD

918 LBS PEOPLE, MOTOR, GEAR

404 LBS PEOPLE

210 HORSEPOWER

SINGLE ENCLOSURE

MAXIMUM CAPACITIES COAST GUARD

918 LBS PEOPLE, MOTOR, GEAR

404 LBS PEOPLE

210 HORSEPOWER

NON-PICTORIALIZATION

USCG MAXIMUM CAPACITIES

4 PEOPLE
150 LBS. EACH

H.P.
200
MAX

914 POUNDS
MOTOR, GEAR, PEOPLE

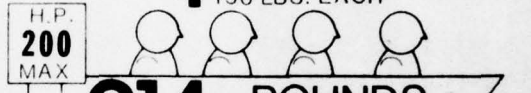
ABCDEF BOAT CO. MODEL 77-44-100

PICTORIALIZATION

USCG MAXIMUM CAPACITIES

4 PEOPLE
150 LBS. EACH

H.P.
200
MAX



914 POUNDS
MOTOR, GEAR, PEOPLE

ABCDEF BOAT CO. MODEL 77-44-100

VERBAL/NUMERICAL ORDER

MAXIMUM CAPACITIES

PEOPLE **4** OR **600** LBS.
150 LBS. EACH

WEIGHT **937** LBS. MOTOR, GEAR AND PEOPLE

MAX H. P.-190 ABCDEF BOAT CO. MODEL 77-44-100

NUMERICAL/VERBAL ORDER

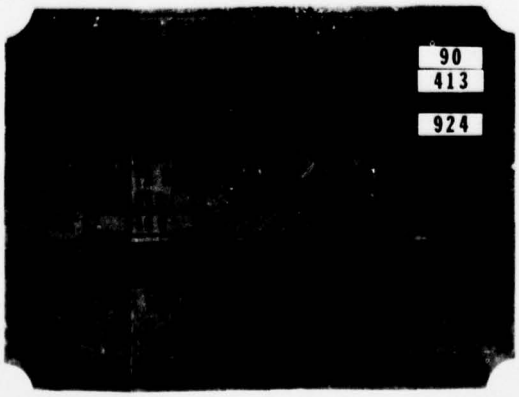
MAXIMUM CAPACITIES

4 PEOPLE OR **600** LBS.
150 LBS. EACH

937 LBS. WEIGHT MOTOR, GEAR AND PEOPLE

MAX H. P.-190 ABCDEF BOAT CO. MODEL 77-44-100

BIA DESIGN



APPENDIX G —
INSTRUCTIONS READ TO SUBJECTS (Ss) — STUDY 3

Each S is escorted to the seat in the experimental room. After S takes his seat (in front of the screen), the experimenter (E) introduces himself, turns out the room lights, and says:

> This is a study to determine the effects of four different ways boat capacity information can be presented on capacity plates. The task for you is a simple one. You are asked to view a series of capacity plates shown on the screen, and to match them when you see a duplication of the numerical capacity information.
>
> Here is how we will show the capacity plates. First you will see a "standard" capacity plate. Write down the numbers that apply to weight and horsepower capacities. Then you will see a series of six capacity plates shown for only an instant. I'll say "ready" and then you will see the capacity plate a moment later. After you see the capacity plate, tell me if it is the same or different from the first one, the standard. We will do this for four different capacity plate designs. Note: the numerical information on the capacity plates will be the same on some of the slides, and some will differ. Your task is to determine when the numerical information is either the same or different. I'll record your answers. Any questions?
>
> Here is how I will show you the capacity plates. This projector is equipped with a camera-like shutter. We can show slides very quickly. For example, here is one slide shown at 150th of a second. What is this the symbol of?

E continues with the sample slides until S appears to understand how the capacity plates will be presented.

E loads the appropriate carousel magazine, and positions the magazine (according to the Experimental Group and to the number of the S.) Then E says:

> Now we are ready to begin the matching. Again, when you see a capacity plate slide with the same information as the standard, tell me "same;" when you see a capacity plate slide with different information from the standard, tell me "different."
>
> Here is the first standard to match. Go ahead and write down the information for weight and for horsepower. Let me know when you are ready for the series of slides to match the standard.

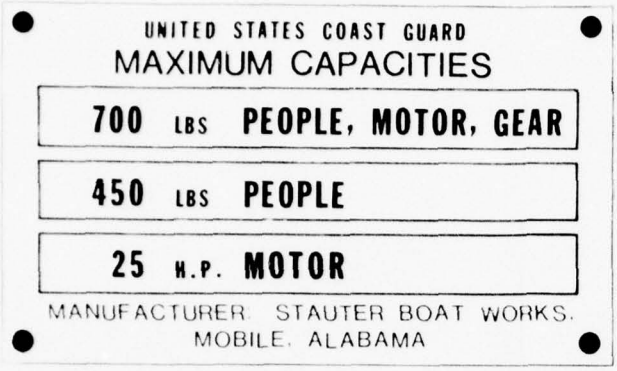
E administers the first series of capacity plate slides, records Ss' responses to the test series shown tachistoscopically, and continues:

> Here is the second standard to match. Go ahead and write down the information for weight and for horsepower. Let me know when you are ready for the series of slides to match the standard. Again, there will be six, of which more than one will be the same as the standard. (Etc. for remaining test sequences)

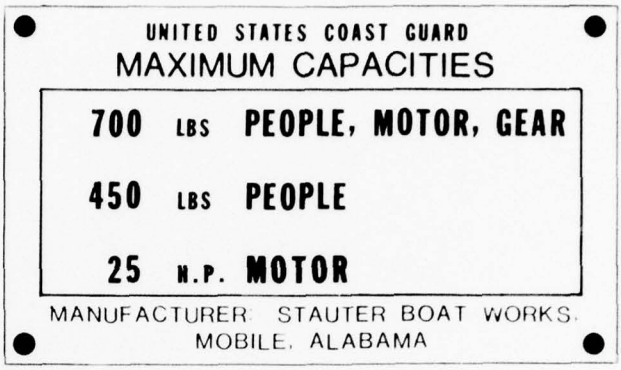
When E has completed the testing, E thanks S for his assistance and terminates the session.

APPENDIX H — FOLDOUT OF DESIGNS FOR STUDY 4

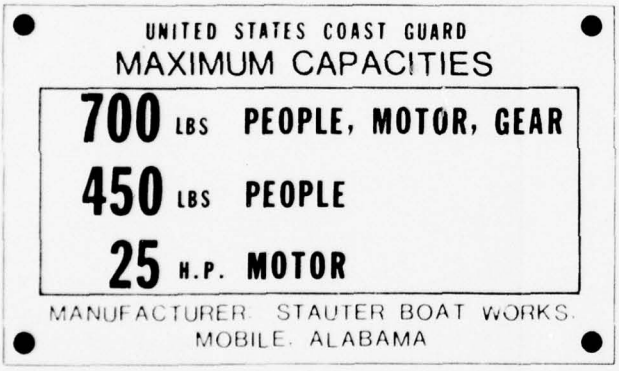
MULTIPLE ENCLOSURE



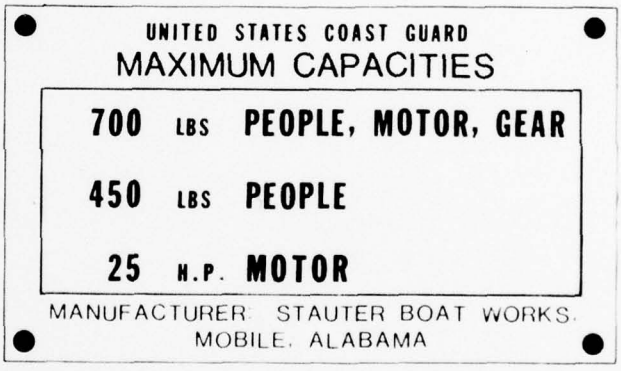
SINGLE ENCLOSURE



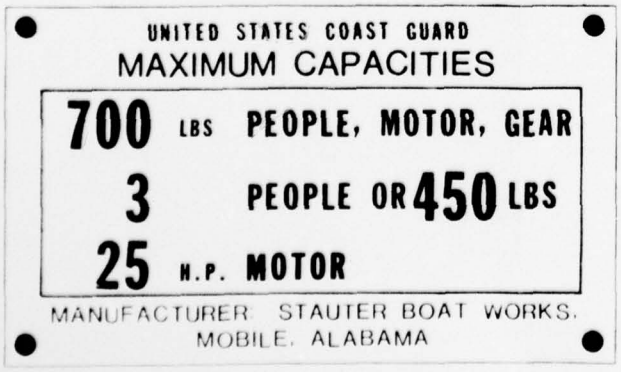
NUMBERS IN LARGE TYPE FACE



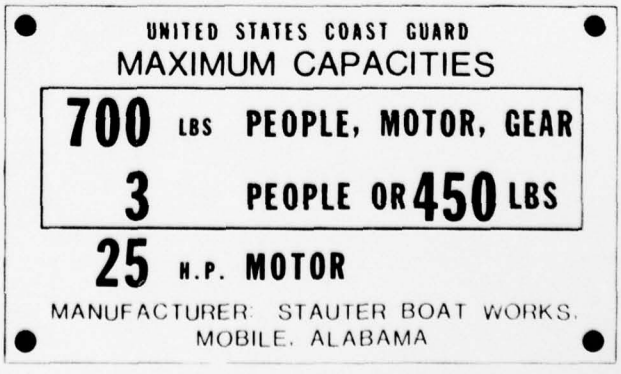
NUMBERS IN SMALLER TYPE FACE



HORSEPOWER CAPACITY WITHIN ENCLOSURE



HORSEPOWER CAPACITY OUTSIDE ENCLOSURE



APPENDIX I — EXPLANATORY LETTER GIVEN TO BOATERS PARTICIPATING IN STUDY 4

WYLE LABORATORIES

Thank you for your cooperation.

Wyle Laboratories is working on ways to increase boating safety. You have assisted us in an attempt to deal with one aspect of the use of rental boats.

The boat which you rented is actually rated for capacities of:

850 lb	People, Motor and Gear
600 lb	People
25	Horsepower

Regardless of the number of people you had in the boat when you left the dock at Tucei's, it was at no time overloaded.

In order to make this project a success, please do not confer with other boaters about the project or about this letter until Tucei assures you that we are finished. Feel free to call Tucei's and verify the boat capacities or to verify Tucei's cooperation with Wyle and the United States Coast Guard.

WYLE LABORATORIES
Eastern Operations
Marine Technology
Huntsville, Alabama

EASTERN OPERATIONS
7800 Governors Drive West
Huntsville, Alabama 35807
837-4411 Area Code 205
TWX 810-726-2225

APPENDIX J -- COMPARISONS OF BOATERS' NOTICING, NOTICING AND READING, AND NOT NOTICING CAPACITY PLATES

Multiple Enclosure (N=8)	Frequency	Percent
Saw and Read Capacity Plate	4	50.0
Saw Capacity Plate; Capacity Plate Not Read	1	12.5
Capacity Plate Not Seen	3	37.5
Single Enclosure (N=3)*		
Saw and Read Capacity Plate	2	66.0
Saw Capacity Plate; Capacity Plate Not Read	1	33.0
Capacity Plate Not Seen	0	0.0
Larger Numbers (N=5)		
Saw and Read Capacity Plate	5	100.0
Saw Capacity Plate; Capacity Plate Not Read	0	0.0
Capacity Plate Not Seen	0	0.0
Smaller Numbers (N=7)		
Saw and Read Capacity Plate	5	71.4
Saw Capacity Plate; Capacity Plate Not Read	1	14.3
Capacity Plate Not Seen	1	14.3
Horsepower Inside Yellow (N=5)		
Saw and Read Capacity Plate	2	40.0
Saw Capacity Plate; Capacity Plate Not Read	1	20.0
Capacity Plate Not Seen	2	40.0
Horsepower Outside Yellow (N=3)		
Saw and Read Capacity Plate	1	33.0
Saw Capacity Plate; Capacity Plate Not Read	2	66.0
Capacity Plate Not Seen	0	0.0

* Values for the single enclosure and smaller numbers design were often combined for the discussion in text. The combined values are presented for summary purposes as follows:

Single Enclosure/Smaller Numbers (N=10)	Frequency	Percent
Saw and Read Capacity Plate	7	70.0
Saw Capacity Plate; Capacity Plate Not Read	2	20.0
Capacity Plate Not Seen	1	10.0

APPENDIX K -- TIME BOATERS FIRST NOTICED CAPACITY PLATES

TYPE DESIGN	TIME CAPACITY PLATES WERE FIRST NOTICED*			
	LOADING BOAT	ON THE WAY OUT OR BEGINNING FISHING	END OF FISHING OR ON THE WAY IN	UNLOADING BOAT
Multiple Enclosure	3**	2	0	0
Single Enclosure	1	1	0	0
Larger Numbers	2	2	1	0
Smaller Numbers	2	3	0	0
Horsepower Inside Yellow	1	1	0	0
Horsepower Outside Yellow	1	0	1	0
TOTALS	10	9	2	0

* No person reported first noticing the capacity plate during fishing.

** Values given in frequency of boater operators

AD-A041 180 WYLE LABS HUNTSVILLE ALA F/G 13/12
SELECTION AND EVALUATION OF PLEASURE BOAT CAPACITY PLATE DESIGN--ETC(U)
NOV 76 E SAGER, M PFAUTH, G LANCASTER, T DOLL DOT-CG-40672-A
UNCLASSIFIED MSR-76-50 USCG-D-18-77 NL

2 OF 2
AD
A041180

END

DATE
FILMED
7-77

APPENDIX L -- COMPUTATIONAL PROCEDURES FOR TWO TAILED "EXACT PROBABILITIES"*

In testing data in a 2 x 2 contingency table, the Fisher Exact Test may be appropriate when expected cell frequencies are too small to permit use of the Chi-Square test. In most discussions of the Fisher technique, procedures are given for computation of a one-tailed test. To obtain two-tailed probabilities, the usual advice is to double the one-tail probability obtained with the Fisher test. However, this may result in an overly conservative statistic. This discussion provides for an alternative, albeit more complicated method for calculating two-tailed probabilities.** It has been the experience of Wyle researchers that the alternative method is more realistic than the "doubling" method. The procedure for computation of the preferred method to obtain the Fisher Exact Test two-tailed probabilities is as follows.

Step One -- Calculate one-tail test probability (lower tail) decrementing on the most extreme small value a (usual computational procedure).

Step Two -- Calculate upper tail probability according to the following method:

1) If either the row marginal sums are equal or the column marginal sums are equal, then the upper tail probability p' is the same as the lower tail probability p, and therefore, the overall probability is twice the probability p found in Step One.

2) If the conditions in 1) are not met, a new table with the same marginal sums must be obtained.

   (i) Let x and y denote the marginal sums in the row and column containing a. For example,

d	c	w
a	b	x
y	z	N

   (ii) Calculate new a-value, a' as follows:

   a' is the smallest integer which is greater than or equal to

$$\frac{2xy - aN}{N}$$

---

* This discussion was prepared by Steve Cohen, PhD, Senior Operations Research Analyst, Wyle Laboratories, Huntsville Facility.

** See Bradley, J. V., Distribution-Free Statistical Tests, Prentice Hall, Englewood Cliffs, N. J., 1968. pp 195 - 203 for additional information on this procedure.

(iii) Using a' and marginal sums, calculate remaining table entries. For example, using the form

d'	c'	w
a'	b'	x
y	z	N

the values are given by

y - a'	w - (x-a')	w	i.e., b' = x - a'
a'	x-a'	x	c' = w - b'
y	z	N	d' = y - a'

(iv) Calculate upper tail probability p' for this table. That is, calculate sum of probabilities for this table and all tables with a more extreme (larger) value of a' up through a' = smaller of x, y.

Note: Step (iv) involves incrementing a' for each new table.

Step Three -- Two-tail probability is sum p + p' of one-tail probabilities.

The following example includes the calculations for two-tail Fisher Exact Test probability for the table

3	12	15
9	7	16
12	19	31

Step One: Calculate lower-tail probability using a = 3 as most extreme small value (Note: 3/15 < 9/16). The result is p = 0.0433.

Step Two: Calculate upper tail probability. Note that 1) does not apply since marginal sums are not equal.

2) Obtain new table having the same marginal sums.

(i) Note marginal sums x and y in row and column containing a. x = 15, y = 12. Also N = 31.

(ii) Calculate a'.

$$a' \geq \frac{2(15)(12) - (3)(31)}{31} = 8.6,$$

a' is smallest integer greater than or equal to 8.6, so a' = 9.

(iii) Calculate remaining table entries.

a' → 9	6	15	(12 - a') = (12 - 9) = 3 = b'
3	13	16	(15 - a') = (15 - 9) = 6 = d'
12	19	31	(16 - b') = (16 - 3) = 13 = c'

(iv) Calculate upper tail probability p' for this table. That is, p' is sum of probabilities in tables with a' = 9, 10, 11, 12.

The upper tail probabilities in this case is p' = 0.0226.

Step Three: The two-tail probability is p + p' = 0.0433 + 0.0226 = 0.0659.

APPENDIX M -- COMPUTATION OF "GOODNESS OF FIT" STATISTIC

Designs	Observed		n	Percent (n/265)	Expected values for χ^2 (n/265 x 122)
Multiple Enclosure	28	correct of	64	0.242	29.52
Single Enclosure/ Smaller Numbers	46	correct of	80	0.302	36.84
Larger Numbers	26	correct of	40	0.151	18.42
Horsepower Inside	15	correct of	45	0.170	20.74
Horsepower Outside	7	correct of	36	0.136	16.59
TOTALS	122		265		----

Computation of χ^2:

Observed (O)	Expected (E)	O-E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
28	29.52	-1.52	2.31	0.078
46	36.84	9.16	83.91	2.278
26	18.42	7.58	57.46	3.119
15	20.74	-5.74	32.95	1.589
7	16.59	9.59	91.97	5.543

($\chi^2 = 12.607$, $df = 4$, $p < 0.05$)

APPENDIX N -- CROSS TABULATION OF WHEN CAPACITY PLATES WERE FIRST NOTICED AND THE FREQUENCY BOATERS CAME TO RENT BOATS

FREQUENCY OF PRIOR VISITS TO CAMP	TIME CAPACITY PLATES WERE FIRST NOTICED*				
	LOADING BOAT	ON THE WAY OUT OR BEGINNING FISHING	END OF FISHING OR ON THE WAY IN	UNLOADING BOAT	TOTAL
Often	55.56** (5)***	33.33 (3)	11.11 (1)	-	100% (9)
Couple of Times	40.00 (2)	60.00 (3)	-	-	100% (5)
First Time	16.67 (1)	66.66 (4)	16.67 (1)	-	100% (6)

* No person reported first noticing the capacity plate during fishing.

** Values given in percentages

*** Values given in frequencies